Alaska Outer Continental Shelf

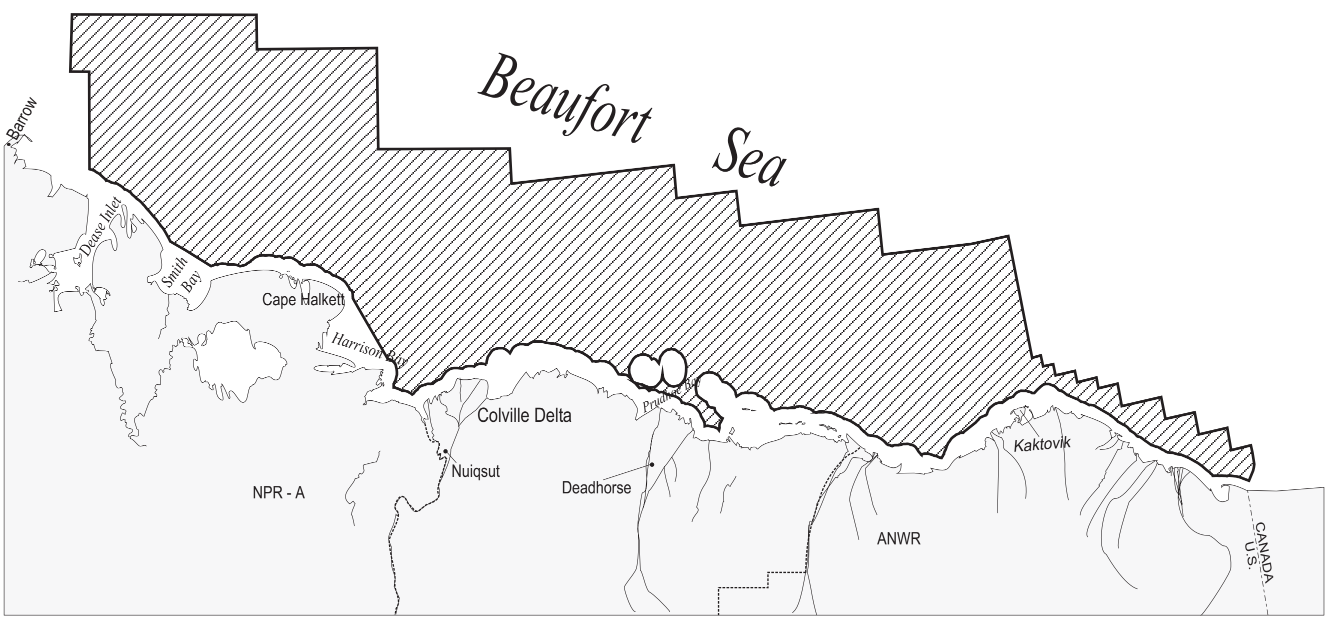
OCS EIS/EA
MMS 2003-001

Beaufort Sea Planning Area

Oil and Gas Lease Sales
186, 195, and 202

Final Environmental
Impact Statement

Volume I
(Executive Summary, Sections I through VI)



U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region

BEAUFORT SEA PLANNING AREA OIL AND GAS LEASE SALES 186, 195, AND 202
Final Environmental Impact Statement
OCS EIS/EA, MMS 2003-001, in 4 volumes:
Volume I, Executive Summary, Sections I through VI
Volume II, Section VII, Bibliography, Index
Volume III, Tables, Figures, and Maps for Volumes I and II
Volume IV, Appendices

The summary is also available as a separate document:
Executive Summary, **MMS 2003-002.**

The complete EIS is available on CD-ROM (**MMS 2003-001 CD**) and on the Internet (**http://www.mms.gov/alaska/cproject/Beafort Sea/**).

This Environmental Impact Statement (EIS) is not intended, nor should it be used, as a local planning document by potentially affected communities. The exploration, development and production, and transportation scenarios described in this EIS represent best-estimate assumptions that serve as a basis for identifying characteristic activities and any resulting environmental effects. Several years will elapse before enough is known about potential local details of development to permit estimates suitable for local planning. These assumptions do not represent a Minerals Management Service recommendation, preference, or endorsement of any facility, site, or development plan. Local control of events may be exercised through planning, zoning, land ownership, and applicable State and local laws and regulations.

With reference to the extent of the Federal Government's jurisdiction of the offshore regions, the United States has not yet resolved some of its offshore boundaries with neighboring jurisdictions. For the purposes of the EIS, certain assumptions were made about the extent of areas believed subject to United States' jurisdiction. The offshore-boundary lines shown in the figures and graphics of this EIS are for purposes of illustration only; they do not necessarily reflect the position or views of the United States with respect to the location of international boundaries, convention lines, or the offshore boundaries between the United States and coastal states concerned. The United States expressly reserves its rights, and those of its nationals, in all areas in which the offshore-boundary dispute has not been resolved; and these illustrative lines are used without prejudice to such rights.

Alaska Outer Continental Shelf

OCS EIS/EA
MMS 2003-001

Beaufort Sea Planning Area
Oil and Gas Lease Sales
186, 195, and 202

Final Environmental
Impact Statement

Volume I
(Executive Summary, Sections I through VI)

Author
Minerals Management Service
Alaska OCS Region

U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region

February 2003

Beaufort Sea
Multiple Sales (186, 195, and 202)
Environmental Impact Statement

Draft ( ) **Final (X)**

Type of Action: Administrative (X) Legislative ( )

Area of Proposed Effect: Offshore marine environment, Beaufort Sea coastal plain, and the North Slope Borough of Alaska.

Responsible Agency: U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region
949 East 36th Avenue
Anchorage, AK 99508-4302

Abstract: This environmental impact statement (EIS) assesses three lease sales in the Proposed Final 2002-2007 5-Year Oil and Gas Leasing Program for the Beaufort Sea OCS Planning Area. Sale 186 is scheduled for 2003; Sale 195 for 2005; and Sale 202 for 2007. The proposed sales include consideration of 1,877 whole or partial lease blocks in the Beaufort Sea Planning Area, covering about 9.8 million acres (3.95 million hectares).

The area considered for the proposed action (Alternative I) is located seaward of the State of Alaska submerged lands boundary, extending from 3 miles to approximately 60 miles offshore and to water depths more than 600 feet, from the Canadian Border on the east, to Barrow, Alaska on the west. For each alternative, the EIS evaluates the effects to the human, physical, and biological resources from routine activities and from the unlikely chance of a large oil spill. Other alternatives include Alternative II (No Lease Sale), which means cancellation of the sale, and four deferral Alternatives (III through VI), which would eliminate various subareas from leasing. A cumulative-effects analysis evaluates the environmental effects of the proposed action with past, present, and reasonably foreseeable future OCS lease sales, as well as non-OCS activities.

Five standard lease Stipulations and 16 standard Information to Lessee (ITL) clauses are evaluated as part of the proposed action. The EIS also evaluates optional stipulations and ITL's.

For further information regarding this EIS, contact:

Paul L. Lowry
Minerals Management Service
949 East 36th Ave., Rm. 308
Anchorage, AK 99508-4302
(907) 271-6574

Dr. George Valiulis
U.S. Department of the Interior
Minerals Management Service
381 Elden Street (MS 4320)
Herndon, VA 20170-4817
(703) 787-1662

ACRONYMS ABBREVIATIONS AND SYMBOLS

Acronyms, Abbreviations and Symbols

ACI	Alaska Consultants, Inc.
ACMP	Alaska Coastal Management Program
ANIMIDA	Arctic Nearshore Impact Monitoring in Development Area (study)
Area ID	Area Identification
Call	Call for Information and Nominations
CFR	Code of Federal Regulations
CMP	Coastal Management Plan
CZM	Coastal Zone Management
EA	Environmental Assessment
EIS	Environmental Impact Statement
ERA	Environmental Resource Area
FONSI	Finding of No Significant Impact
FR	*Federal Register*
ISER	Institute for Social and Economic Research
ITL	Information to Lessees (clause)
LC_{50}	96-hour lethal concentration for 50% of test organisms
MMS	Minerals Management Service
NEPA	National Environmental Policy Act
NSB CMP	North Slope Borough Coastal Management Program
NSBMC	North Slope Borough Municipal Code
PM_{10}	particulate matter less than 10 microns in diameter
PSD	Prevention of Significant Deterioration
OCS	Outer Continental Shelf
UAA	University of Alaska, Anchorage
USDOI	U.S. Department of the Interior
U.S.C.	United States Code
dB re 1µPa	decibels re 1 microPascal
°	degree(s)
%	percent

THE 2003 BEAUFORT SEA MULTIPLE–SALE

FINAL EIS

What It Includes

and

How It's Structured

The 2003 Beaufort Sea Multiple-Sale EIS
What it Includes and How It's Structured

Overview and General Information

These two pages provide a quick overview of what is in this draft environmental impact statement (EIS) and how it is structured. Because the draft EIS is somewhat complicated, we in the Minerals Management Service (MMS) urge you to read this first.

In April 2002, the Secretary of the Interior issued a Proposed Final 5-Year Offshore Oil and Gas Leasing Program for 2002-2007. It includes three lease sales on the Beaufort Sea outer continental shelf—Sale 186 scheduled in 2003, Sale 195 in 2005 and Sale 202 in 2007. This multiple-sale EIS assesses environmental effects of these sales, all three of which consider for leasing the same geographical area in the Beaufort Sea (from near the City of Barrow to the Canadian border). As MMS begins preparations for each of the latter two sales, we will do an Environmental Assessment (EA) to determine if the EIS is still adequate or if a supplemental EIS is needed. Those EA's will be available for public review and comment.

The MMS has successfully used offshore multiple-sale EIS's in the Gulf of Mexico Region. Such an approach is encouraged by the National Environmental Policy Act (NEPA). It avoids publication of nearly duplicate documents and staff "burnout" in local, State, and Federal reviewing agencies and saves MMS staff and financial resources. It also focuses readers on the key environmental issues that are very similar for each sale.

Traditional knowledge information and observations appear throughout the EIS, along with those of Western science.

We have attempted to use and cite the latest and best information available in this EIS. When information in the literature was limited, authors used their best professional judgment in describing effects. If you have any suggestions about the format and writing style, we hope you include them in your comments. If you feel any critical references were omitted, please describe them as specifically as possible. Thank you.

This draft EIS is available in paper copy and as a CD/ROM. The CD/ROM is convenient to use, has numerous hyperlinks, and saves substantially on paper, printing, and postage costs.

Executive Summary: This sets out the geographic scope and context of the proposed sales and then summarizes the issues raised in written and oral scoping comments. We introduce the concept of infrastructure/water depth zones and lay out the development scenarios we created for purposes of analysis for each sale in each zone. We describe three groups of effects of the proposal (Alternative I) for each sale: effects from routine permitted activities, effects from an unlikely large oil spill, and cumulative effects.

The Executive Summary then summarizes the effects of No Action (Alternative II) and the effects of the four deferral alternatives: the Barrow, Nuiqsut, and Kaktovik Subsistence Whaling Deferrals and the Eastern Deferral (Alternatives III-VI). Finally, we touch on the mitigating measures and a context for considering alternatives and mitigating measures.

Section I Purpose and Background of the Proposed Actions: This section gives fairly conventional treatment to the purpose, need, and description of the proposed actions for the three sales in addition to the legal mandates and a summary of the results of the scoping process.

We then describe the six alternatives, the sale proposal, no action, and four deferrals, all of which are the same for the three sales. Next is our rationale for "scoping out" other recommended deferrals. We then list the mitigation measures (both the Stipulations and Information to Lessees [ITL clauses]) and summarize information on Indian Trust Resources and Environmental Justice. The section ends with a description of the NEPA process for the three sales and our attempt to keep the EIS as concise as possible.

Section II Alternatives, Including the Proposed Action: We start with a detailed description of our analytical approach to assessing the hydrocarbon-resource potential of the Beaufort Sea and the development scenarios of offshore operational activities that we create and use to estimate environmental effects. We introduce the "opportunity index" to describe the risk-weighted probability of discovering and developing an economic field in particular areas of the Beaufort Sea.

We then describe in detail each of the 6 alternatives and each of the 5 standard and 3 additional stipulations and 16 standard and 1 additional ITL clause.

Section III Description of the Affected Environment: This is a fairly standard description of the physical characteristics, biological resources and social systems.

Section IV– Environmental Consequences: This is the heart of the EIS. We begin with detailed information on all the basic assumptions used in our assessment of effects. Then, we describe the positive and negatives effects of taking no action (Alternative II). The bulk of the analysis of effects in this section is grouped by the 16 resource categories that we address:

- Water Quality
- Lower Trophic-Level Organisms
- Fishes
- Essential Fish Habitat
- Endangered and Threatened Species
- Marine and Coastal Birds
- Marine Mammals
- Terrestrial Mammals
- Vegetation and Wetlands
- Economy
- Subsistence-Harvest Patterns
- Sociocultural Systems
- Archaeological Resources
- Land Use Plans and Coastal Management
- Air Quality
- Environmental Justice

Under most all of the above categories, we first present the general effects of noise, disturbance, etc. from permitted activities and then the general effects of oil spills and the effects of an unlikely large spill with associated cleanup activities. We then analyze the effects on the particular resource category of each alternative, with subheadings for each sale. We treat a few categories, such as Economy and Environmental Justice, somewhat differently.

We end the section with analysis of a variety of topics required by NEPA, the effects of natural gas development and production, and the effects to resources from a very large, but extremely unlikely, blowout oil spill.

Section IV Cumulative Effects: This section presents the conceptual approach used in analyzing cumulative effects, then details the past, present and reasonably foreseeable future activities that contribute to cumulative effects. The bulk of the analysis is cumulative effects by resource. We assess sequentially the cumulative effects on the 16 previously-mentioned resource categories and end each subsection with a concluding statement of the contribution that the proposal for Sale 186 makes to the cumulative effects.

Section VI Consultation and Coordination: Here we include organizations and/or individuals with whom we consulted, who provided written or oral scoping comments, or are on our mailing list. We also include a list of contributing authors and support staff.

Section VII Review and Analysis of Comments Received: This section provides copies of the comments we received by letter, email, or as testimony at the hearings. We have assigned a number to each letter (L-0001 to L-0040) and assigned the name to each public hearing (i.e. PH Barrow or PH Kaktovik). Within each letter and pubic hearing we have identified the comments requiring a response with another three digit number. The combination of both these numbers (L-0020.001 or PH Barrow.001) provides a unique identifier for each comment and response. The responses to comments for each letter or public hearing are provided immediately after the letter or hearing. E-mails tend to be repetitive and contain comments previously answered either within the letter or public hearing comments; consequently, we have included representative examples of e-mails received. E-mails are numbered with an E followed by the sequence in which it was received at the Alaska Region Website (E-2301).

Appendices: These include technical information on oil spills, resource estimates, the Endangered Species Act, other applicable laws and regulations, and the scoping report.

EXECUTIVE SUMMARY

CONTENTS OF EXECUTIVE SUMMARY

Executive Summary: Beaufort Sea Multiple Sale Environmental Impact Statement for Sales 186, 195, and 202

ES.1.a Introduction and Background

This environmental impact statement (EIS) assesses three lease sales in the Proposed Final 2002-2007 5-Year Oil and Gas Leasing Program for the Beaufort Sea OCS Planning Area. Sale 186 is scheduled for 2003; Sale 195 for 2005; and Sale 202 for 2007. Federal regulations (40 CFR 1502.4) suggest analyzing similar sales in a single EIS. The proposal for each sale is to offer 1,877 whole or partial lease blocks in the Beaufort Sea Planning Area, covering about 9.8 million acres (3.95 million hectares) for leasing (see Map 1). The proposed sale area is seaward (up to 60 miles offshore) of the State of Alaska submerged lands boundary in the Beaufort Sea. It extends from the Canadian Border on the east to near Barrow, Alaska on the west. Although the water depths may exceed 600 feet, most, if not all, exploration and development activities that may occur likely would take place in water depths less than 125 feet. For purposes of analysis, the MMS assumes that 460 million barrels of oil could be discovered and produced for each sale, based on an estimated range of 340-570 million barrels per sale. Only a small percentage of the blocks available for lease under the proposed action for Sales 186, 195, and 202 likely would be leased. Of the blocks that would be leased, only a portion would be drilled. Of these, only a very small portion, if any, likely would result in production. At this time, gas is not considered economically recoverable. See Map 17 – Historical Sales, Areas Previously Offered in Beaufort Lease Sales; and Map 16 – Historical Sales, Blocks Leased in Previous Beaufort Sales.

ES.1.b Scoping

Scoping is the ongoing public process to identify issues to be analyzed in depth in the EIS. Public scoping meetings were held in Barrow, Kaktovik, Nuiqsut, and Anchorage. We received both oral and written comments from a number of constituents. Respondents include affected local, tribal, State and Federal agencies, the petroleum industry, Native groups, environmental and public interest groups, and concerned individuals. The input we received from these sources aided us in identifying significant issues, possible alternatives, and potential mitigating measures. As part of our local scoping process, we held a government-to-government dialog with Native groups, both in formal agency meetings and in the open public forum. Traditional Knowledge, Environmental Justice, Indian Trust Resources, and Government-to-Government Coordination are addressed in this EIS.

The MMS identified the following major issues from the scoping comments:

- habitat disturbances and alterations, including discharges and noise
- disturbance to bowhead whale-migration patterns from resulting activities
- protection of subsistence resources and the Inupiat culture and way of life
- effects from accidental oil spills
- incorporation of traditional knowledge in the EIS and its use in decisionmaking
- cumulative effects of past, present, and reasonably foreseeable future activities on the people and environment of Alaska's North Slope
- development of a single EIS for each proposed lease sale, rather than one multiple-sale EIS covering all proposed lease sales, is favored by the NSB

ES.1.c Infrastructure/Water-Depth Zones

For purposes of analysis, the MMS has divided the Beaufort Sea Planning Area into three zones. These zones are defined primarily by their proximity to existing North Slope infrastructure and secondarily by water depths. Distance from existing infrastructure is a major economic factor. The farther away a project is located from existing infrastructure, the higher the costs; therefore, a greater quantity of oil is needed to make the project economic. Water depths will influence the types of structures used for exploration and development. The Near/Shallow Zone is located in the central Beaufort Sea (offshore Prudhoe Bay) between the Canning River on the east and Colville River on west in water depths less than 30 feet (about 10 meters) (see Map 4). The Midrange/Medium Zone is farther away from development, extending from Barter Island in the east to Cape Halkett in the west and in water depths between 30 and 100 feet (about 10-30 meters). The Far/Deepwater Zone extends from the Canadian Border in the east to near Barrow in the west, and water depths may exceed 600 feet (200 meters), although we expect most development would take place in water depths less than 125 feet (35 meters) and within 25 miles from shore.

Past experience has shown that exploration and subsequent development likely will expand into areas that are more remote and of higher cost after opportunities are largely exhausted in areas that are easily accessible. For this reason, the development scenarios and associated analyses will change slightly with each sale. We assume that with the holding of each sale, commercially recoverable resources will lie in deeper offshore water and/or farther from existing infrastructure. However, no one can know, with any degree of certainty, how, when and if development will actually evolve in the Beaufort Sea.

ES.1.d Development Scenarios for Each Sale

For Sale 186, the MMS estimates most leasing (70%) would take place in the Near Zone, 20% in the Midrange Zone, and only 10% in the Far Zone. For purposes of analysis, we assume two potential developments in the Near Zone and one in the Midrange Zone. For Sale 195, industry interest would broaden with 50% of the leasing in the Near Zone, 30% in the Midrange Zone, and 20% in the Far Zone. We assume two potential developments would occur, one in the Near Zone and one in the Midrange Zone. For Sale 202, industry interest would move farther offshore and away from the central Beaufort Sea. We assume 40% of the leasing would occur in the Near Zone, 30% in the Midrange Zone, and 30% in the Far Zone; we assume a single development in the Far Zone. Although the scenarios prepared for this EIS assume a reasonable percentage of leasing and one development in the Far Zone until Sale 202 leases, companies could bid on and be awarded leases in any of the zones in any of the three sales. Moreover, the effects evaluated in this EIS that are attributed to any particular zone or sale for the scenarios MMS developed could occur as a result of any lease sale, if they occur at all.

ES.1.e Environmental Effects of the Proposal (Alternative I) for Sales 186, 195, and 202

See Map 2 for Beaufort Sea Multiple-Sale Deferral Alternatives.

ES.1.e(1) Effects from Routine Permitted Activities

If any of the lease sales are held and result in exploration and/or development, routine industrial activities associated with oil exploration and development would generate some degree of disturbance, noise, and discharges into the environment (see Table IV.A-4). The EIS found that no significant effects are anticipated from routine permitted activities. Significance thresholds are defined in Section IV.A.1 of the EIS.

Potential effects to water quality from any or all of the sales would be of short duration and localized to a few square kilometers from the discharge site, but there likely would be no regional effects. Effects to lower trophic-level organisms from increased turbidity from permitted construction activities would be local and short term. Nearby benthic organisms would experience sublethal effects from permitted discharges of drilling muds and cuttings over the life of the field. No measurable effect on fish populations (including incidental anadromous species) would be likely. Although a few individual fish could be harmed or killed during construction, most fish in the immediate area likely would avoid these activities and would be otherwise unaffected. Effects on most overwintering fish are likely to be short term and sublethal, with no measurable effect likely on overwintering fish populations. Effects to essential fish habitat potentially likely would be greatest in the central Beaufort Sea onshore area, where the lakes and rivers in the area provide the best freshwater (overwintering) habitat. Effects on prey to essential fish habitat likely would be localized, with low population changes in abundance and distribution and for a short time. Ice-road construction, which uses some freshwater, could have moderate to low effects to onshore freshwater habitat by removing up to 15% of an overwintering waterbody. Removal of water from a lake or deep-water hole in a river potentially could reduce survival of overwintering juvenile salmon.

The endangered bowhead whale may exhibit temporary avoidance behavior to seismic surveys, vessel and aircraft activities, drilling, and construction, but overall effects to bowheads from disturbance and noise likely would be temporary and nonlethal. Disturbance associated with construction activities of the threatened spectacled and Steller's eiders may cause decreased fitness or production of young. Eider mortality from collisions with structures is not likely to be a significant effect. Frequent disturbance during the construction of exploration or production facilities may cause decreased fitness or production of young to marine and coastal birds. Bird mortality from collisions with structures is not likely to be a significant effect. Small numbers of marine mammals (pinnipeds, polar bears, and beluga and gray whales) could be affected, with recovery expected in about 1 year. Small numbers of terrestrial mammals (caribou, muskoxen, grizzly bears, and arctic foxes) may be affected by construction activities, with recovery expected in 1 year. Caribou could be displaced within 1-2 kilometers along the pipeline and roads, but this should not affect caribou migration and overall distribution. Destruction of less than a few hundred acres of vegetation and wetlands from gravel mining, construction of a landfall gravel pad, and onshore pipeline installation likely would occur, with effects persisting for more than 10 years. Periodic disturbances could affect subsistence-harvest resources, but no resource or harvest area likely would become unavailable, and no resource population likely would experience an overall decrease.

Chronic disruptions to sociocultural systems likely would occur, but these disruptions are not likely to cause permanent displacement of ongoing traditional activities of harvesting, sharing, and processing subsistence resources. No "disproportionately high adverse effects" as defined by the Environmental Justice Executive Order would likely occur from planned and permitted activities associated with any of the three proposed OCS lease sales evaluated in this EIS. Disturbance of historic and prehistoric archaeological resources is possible, but not likely, during exploration and development activities both onshore and offshore. However, terrestrial and marine archaeological surveys should identify any potential resource prior to activities taking place, and they can be avoided or their effects can be mitigated. Air quality effects likely would not cause ambient air quality standards to be exceeded.

Based on the assumed discovery and development of 460 million barrels of oil, some economic benefits could occur as a result of each lease sale: $15 million in revenue to the North Slope Borough, $190 million to the State of Alaska, and $930 million to the Federal Government. An average of 800 jobs over 30 years could occur, and if so, they would represent about $1.7 billion in total personal income for these workers. Alternative I also likely would result in a longer lifespan for the Trans-Alaska Pipeline System. No conflicts are anticipated with the Statewide standards of the Alaska Coastal Management Plan or the enforceable policies of the North Slope Borough.

ES.1.e(2) Effects in the Unlikely Event of a Large Oil Spill

Other effects from any or all of the sales are possible from unlikely events, such as a large, accidental oil spill. The MMS's estimated mean number of one or more spills greater than or equal to 1,000 barrels for any one of the proposed sales is 0.11, and the most likely number of spills greater than or equal to 1,000 barrels is zero for any of the proposed sales. The chance of one or more large spills greater than or equal to 1,000 barrels for each of the three sales is 8-10%. For purposes of analysis, we assume one large spill of either 1,500 barrels (platform spill) or 4,600 barrels (pipeline spill). In the unlikely event of such an oil spill, significant adverse effects could occur to local water quality; common, spectacled, and Steller's eiders; long-tailed ducks; subsistence harvests; and sociocultural systems. However, the low probability of such an event, the likelihood that a spill will not move into all portions of a given area, and the seasonal nature of the resources inhabiting the area, make it quite unlikely that a large oil spill would occur and contact substantial portions of these resources. With regard to seasonality, although spectacled eiders, long-tailed ducks, and common eiders are present on the North Slope for only 3-5 months of the year, the potential exists for cumulative effects from contact in succeeding years if all oil is not removed from the environment the first year.

Water quality could be affected by hydrocarbons from small spills, resulting in local, chronic hydrocarbon contamination. In the unlikely event of a large spill, hydrocarbons could exceed the 1.5 parts per million acute toxic criterion for water quality during the first day of a spill and the 0.015 parts per million chronic criterion for about a month thereafter in a small bay. Such an oil spill could have lethal and sublethal effects on less than 1% of the plankton and lower trophic-level organisms in the coastal band of high production and (assuming a winter spill) less than 5% of the epontic organisms in the landfast-ice zone. Recovery of plankton stock likely would occur within a week (2 weeks in bays). A large spill likely would have lethal and sublethal effects on less than 1% of the benthic invertebrates in shallow areas. Recovery likely would occur within a month (within a year where water circulation is significantly reduced).

We estimate less than a 0.5% chance of a large oil spill occurring and contacting nearshore Beaufort Sea fish habitat, where fish tend to concentrate during the spring and summer to feed and move about. Oil spills are likely to result in minor, short-term effects on relatively small numbers of fishes. A large oil spill probably would pose some risk to essential fish habitat, and these effects would be considered moderate, because salmon and salmon habitat would recover within one generation. One year of smolting salmon could be affected, and salmon populations likely would recover. Effects on freshwater and marine habitats likely would be low. Some bowhead whales likely would experience temporary, nonlethal effects, if a large oil spill occurred. The probability of oil contacting whales likely would be considerably less than the probability of oil contacting bowhead habitat. In the unlikely event a large spill occurred and contacted bowhead habitat during the fall migration, some whales likely would be contacted by oil, and it is possible that a few could die as a result of the contact. In the event of such a spill in the vicinity of spectacled eiders, mortality likely would be fewer than 100 individuals; however, any substantial loss (25+ individuals) would represent a significant effect. Recovery from substantial mortality would not be expected to occur while the population exhibits a declining trend. Low Steller's eider mortality would be likely from a large oil spill in late spring or in early summer. Recovery of the Alaska population from spill-related losses, however, would not occur while the regional population is declining. In the unlikely event of a large oil spill, mortality to marine and coastal birds likely would reflect local population size and vulnerability determined by seasonal habitat use and the stage of annual cycle at the time of contact (for example, molting versus nonmolting). Depending on the completeness of oil cleanup, the risk of contact may extend to future seasons when vulnerable birds are present. Long-tailed duck mortality likely would exceed 1,000 individuals, while that of other common species, such as king eider, common eider, and scoters, likely would be in the low hundreds. For loon species, mortality likely would be fewer than 25 individuals each. During migration periods, potentially much greater mortality could occur as new migrants enter the spill area.

A large oil spill, even though unlikely, could result in the loss (lower reproductive rates or death of individual animals) of small numbers of marine mammals (seals, walruses, polar bears, and beluga and gray whales), perhaps 100-200 ringed seals but probably fewer than 10-20 spotted seals, 30-50 bearded seals, fewer than 100 walruses, 6-10 polar bears, and fewer than 10 beluga and gray whales, with populations likely recovering within about 1 year. For terrestrial mammals, such a spill during the same period that the animals used the coastal waters or nearshore areas, would likely result in the loss of no more than a small number of caribou (a few hundred), fewer than 10 individual muskoxen, grizzly bears, and arctic foxes, with recovery estimated to occur within about 1 year. A large oil spill and spill-cleanup activities could affect a few acres of vegetation and wetlands for more than 10 years.

A large oil spill likely would affect the local economy and create additional employment of 60-190 jobs for up to 6 months. In the unlikely event that a large oil spill occurred and contaminated essential whaling areas, major (significant) effects could occur with impacts from shoreline contamination, tainting concerns, cleanup disturbance, and disruption of subsistence-harvest practices and the sociocultural systems. Oil-spill cleanup could increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to these species and, therefore, alter or extend the normal subsistence hunt. The effects of a large oil spill to air quality would be a small local and temporary increase in the concentration of gaseous hydrocarbons due to evaporation of the spill. The concentrations of criteria pollutants likely would remain well within Federal air quality standards. Oil-spill-cleanup activities also could disturb archaeological sites. Because large oil spills are unlikely events, no adverse effects are anticipated to the Statewide standards of the Alaska Coastal Management Plan or the enforceable policies of the North Slope Borough.

ES.1.e(3) Cumulative Effects

The MMS does not expect any significant cumulative impacts to result from any of the routine activities associated with Alternative I for Sale 186. For the cumulative analysis in this EIS, effects of the other alternatives for Sale 186, if chosen, and for Alternative I for Sales 195 and 202 and the other action alternatives, would be essentially the same as those for Alternative I for Sale 186. This is because in the cumulative effects analysis, we assess the estimated contribution of Alternative I for Sale 186 to the estimated combined effects of all the past, present, and reasonably foreseeable activities that are likely to affect the same resources likely be affected by Sale 186. The differences in effects among the proposed sales and their alternatives are so small, that we cannot reliably distinguish measurable differences relative to the combined estimated effects in the cumulative effects analysis. Another reason we cannot reliably distinguish measurable differences is due to the inherent uncertainty involved in estimating the combined effects of the potential future activities.

If the activities associated with scenarios developed for Alternative I for Sale 186 occurred, we estimate that they would contribute about 9% of the offshore cumulative effects in the Beaufort Sea from oil exploration and development and about 2% of the combined cumulative onshore and offshore effects. In the unlikely event of a large offshore oil spill, some significant cumulative effects could occur, such as adverse effects to common and spectacled eiders, long-tailed ducks, subsistence resources, sociocultural systems, and local water quality. However, the low probability of such an event, the likelihood that a spill would not move into all parts of a given area, and the seasonal nature of the resources inhabiting the area, make it unlikely that a large oil spill would occur and contact substantial portions of these resources. Although spectacled eiders, long-tailed ducks, and common eiders are present on the North Slope for only 3-5 months out of the year, the potential exists for cumulative effects from contact in succeeding years if all oil is not removed from the environment the first year. A resource may be present in the area but would not necessarily be contacted by a spill that covered only part of the area. A large oil spill, however unlikely, could affect the availability of bowhead whales, or the resource might be considered tainted and unusable as a food source. The potential for adverse effects to some key resources (bowhead whales, subsistence-harvest patterns, polar bears, eiders, and caribou) from such a large spill are of concern and warrant continued close attention.

ES.1.e(4) Agency-Preferred Alternative

As required by the National Environmental Policy Act Council on Environmental Quality regulations, the MMS has identified a preferred alternative for this final EIS. The agency-preferred alternative is Alternative I, along with the standard stipulations and ITL clauses, plus three optional mitigating measures: Stipulation 7 - Pre-Booming Requirements for Fuel Transfers; Stipulation No. 8 - Lighting of Structures to Minimize Effects to Spectacled and Steller's Eiders; and ITL No. 17 - Information to Lessees on Archaeological and Geological Hazards Reports.

We do not provide a separate evaluation of this alternative, because it would repeat the entire analysis provided for Alternative I (See Section IV.C of the EIS). The effects of the agency-preferred alternative essentially are the same as those noted for Alternative I with some additional protection to bowhead whales, subsistence-whaling activities, eiders, and archaeological resources. Also, the protections provided by the agency-preferred alternative would be about the same as those provided by selection of all four of the deferral alternatives.

ES.1.f Effects of Alternatives II through VI

In addition to Alternative II - No Lease Sale, four deferral alternatives were identified during the scoping process for analysis in the EIS. These action alternatives are evaluated as options for each of the three proposed sales (186, 195, and 202). Although Alternatives III through VI provide limited additional protection to resources that could be affected by oil and gas activity in the deferral areas, the deferrals do not change the estimated significant adverse effects identified in Section ES.1.e of this Executive Summary for any of the three sales.

Alternative II (No Lease Sale) equals cancellation of the sale. Several individuals suggested this alternative during scoping. Neither the estimated possible oil production nor the potential environmental effects resulting from the proposed actions for Sales 186, 195, or 202 would occur. While this alternative would provide protection to the environmental resources in the Federal offshore area of the Beaufort Sea, the environmental impacts from a global perspective likely would not be decreased. Most of the oil that would not be produced in the U.S. if Alternative II were selected instead would be imported to the U.S. in foreign tankers. Assuming that the amount of oil resources used in the U.S. continues at current rates, oil production in foreign countries would be increased; therefore, the environmental consequences described under Alternative I would not occur, but the production and transportation of the replacement oil would cause environmental consequences elsewhere. From a global perspective, selection of Alternative II (No Lease Sale), would be a decision for the U.S. to export these environmental effects. This same transfer of environmental consequences holds true for any oil not produced if any of the other deferral alternatives are chosen.

Also, the U.S. would suffer a substantial loss of economic benefits if Alternative II were selected. For Sale 186, Alternative II would result in a loss of about $15 million in revenue to the North Slope Borough, $190 million to the State of Alaska, and $930 million to the Federal Government. An average of about 800 jobs over 30 years would be lost, representing a total of about $1.7 billion of total personal income for these workers. Alternative II (No Action) also likely would result in a shorter lifespan for the Trans-Alaska Pipeline System. The economic losses if Sale 195 and 202 are not held would be similar.

Alternative III - Barrow Subsistence Whaling Deferral would defer offering 26 whole or partial blocks located in the western part of the U.S. Beaufort Sea, with 1,851 whole or partial blocks (about 9.6 million acres) remaining available for leasing. This alternative was developed in response to issues raised by Barrow residents and the Alaska Eskimo Whaling Commission concerning reduction of potential adverse effects to subsistence whaling activities near Barrow. The aerial extent of the potential deferral is based, in part, on data provided by the Alaska Eskimo Whaling Commission and is designed to add protection for subsistence-whaling areas in the vicinity where most whale strikes have occurred near Barrow over the past decade. Deferring this area for any of the three lease sales would provide limited additional protection to all the resources in the area, but the overall effects likely would be essentially the same as Alternative I. Deferring these blocks from any lease sale could reduce effects on subsistence resources, particularly the bowhead whale hunt in the vicinity of Barrow. This deferral also would reduce, by about 1%, the opportunity of discovering and developing an economic oil field from the lease sale.

Alternative IV - Nuiqsut Subsistence Whaling Deferral would defer offering 30 whole or partial blocks located offshore of Nuiqsut, with 1,847 whole or partial blocks (about 9.6 million acres) remaining available for leasing. This alternative was developed in response to issues raised by Nuiqsut residents and the Alaska Eskimo Whaling Commission concerning reduction of potential impacts to subsistence whaling activities near Cross Island, which is the base for most Nuiqsut whale-hunting activities. It is based, in part, on data provided by the Alaska Eskimo Whaling Commission and is designed to provide additional protection for subsistence-whaling areas in the vicinity where most whale strikes have occurred near Nuiqsut over the past decade. Deferring this area from any of the three proposed lease sales would provide limited additional protection to all the resources in the area, but the overall effects likely would be essentially the same as Alternative I. Deferring these blocks from any lease sale could reduce effects on subsistence resources, particularly the bowhead whale hunt in the vicinity of Cross Island. This deferral also would reduce, by about 5%, the opportunity of discovering and developing an economic oil field from the lease sale.

Alternative V - Kaktovik Subsistence Whaling Deferral would defer offering 28 whole or partial blocks located offshore of Kaktovik, with 1,849 whole or partial blocks (about 9.7 million acres) remaining available for lease under this alternative. This alternative was suggested by and based on data provided by the Alaska Eskimo Whaling Commission to protect subsistence-whaling areas in the vicinity where most whale strikes have occurred near Kaktovik over the past decade. Deferring this area from any of the three proposed lease sales would provide additional limited protection to all the resources in the area, but the overall effects likely would be essentially the same as Alternative I. Deferring these blocks from any lease sale could reduce effects on subsistence resources, particularly the bowhead whale in the vicinity of Kaktovik. This deferral also would reduce, by about 3%, the opportunity of discovering and developing an economic oil field from the lease sale.

Alternative VI - Eastern Deferral would defer offering 60 whole or partial blocks located east of Kaktovik, with 1,817 whole or partial blocks (about 9.6 million acres) remaining available for leasing. This area was suggested during scoping as an important bowhead whale-feeding area. However, a recent study of bowhead whale feeding in this area does not confirm this suggestion.

Deferring this area from any of the three proposed lease sales would provide limited additional protection to all the resources in the area, but the overall effects likely would be essentially the same as Alternative I. Deferring these blocks from any lease sale could reduce some effects on subsistence resources. This deferral also would reduce, by about 3%, the opportunity of discovering and developing an economic oil field from the lease sale.

The scenarios for all alternatives, except the No Lease Sale alternative, for Sales 186 and 195 assume development would occur in the Near and Midrange zones. The same level of activity likely would occur regardless of the alternatives evaluated. The MMS analysts identified a benefit to subsistence-harvest patterns and sociocultural systems in selecting Alternatives III, V, and VI for Sale 202, because the scenario assumes exploration and development activity would be expected in the Far Zone. Selecting Alternative IV provides similar benefits to subsistence-harvest patterns and sociocultural systems for all three sales. However, these observed differences do not equate to significant differences of effects among alternatives or among sales. Likewise, although the effects of Alternatives III, V, and VI for Sales 186 and 195 do show observed differences, they do not equate to significant differences of effects.

If the Secretary of the Interior decides to proceed with each of the sales (186, 195, and 202), by not choosing Alternative II - No Lease Sale, the Secretary may choose one, all, some combination, or part of the deferral options to comprise the final Notice for Sale 186. The Secretary will have the full suite of options available for Sales 195 and 202 when those decisions are made in 2005 and 2007, respectively. The Secretary may choose the same options selected for Sale 186 or different options.

ES.1.g Mitigating Measures

Five standard lease stipulations are evaluated as part of all the alternatives for all three proposed lease sales. These stipulations are:

Stipulation 1 - Protection of Biological Resources

Stipulation 2 - Orientation Program

Stipulation 3 - Transportation of Hydrocarbons

Stipulation 4 - Industry Site-Specific Bowhead Whale-Monitoring Program; and

Stipulation 5 - Subsistence Whaling and Other Subsistence-Harvesting Activities.

We have included these stipulations in previous Beaufort Sea lease sales. Combined, these stipulations help lower the potential adverse effects of any proposed lease sale and help protect subsistence-harvest activities and sociocultural systems. Adoption of these measures would be a positive action under Environmental Justice. Stipulations 1 and 5 have been modified, but only slightly, from the version adopted for Sale 170. The list of blocks in Stipulation 4 has been updated.

Previous Stipulation 6 has been divided into two parts and two additional stipulations are evaluated in this EIS.

Stipulation 6 - Permanent Facility Siting in the Vicinity of Cross Island. Stipulation 6a would prohibit the siting of permanent oil- and gas-development facilities within a 10-mile radius seaward of Cross Island, a subsistence-whaling area used by the Native community of Nuiqsut, unless the lessee demonstrates to the satisfaction of the Regional Director, in consultation with the North Slope Borough and the Alaska Eskimo Whale Commission, that the development will not preclude reasonable access to subsistence bowhead whales. Stipulation 6b is identical, except that it is applied to the area shoreward of Cross Island. The stipulation is designed to eliminate or reduce potential disturbance to subsistence activities. Stipulation 6a would provide some reduction in potential effects to subsistence-harvest patterns and sociocultural systems to the community of Nuiqsut. The primary subsistence-whaling area used by Nuiqsut is seaward of the barrier islands. Stipulation 6b would not lower the effects to any resource categories in a measurable way. Stipulation 6a could be as effective in lower impacts as selecting Alternative IV - Nuiqsut Subsistence Whaling Deferral.

Stipulation 7 - Pre-Booming Requirements for Fuel Transfers would lower the potential effects to subsistence resources and sociocultural systems by providing additional protection to the bowhead whale from potential fuel spills that may occur just prior to or during the bowhead whale-migration period. This stipulation would be an added caution to further reduce the chance of any fuel contacting a bowhead whale.

Stipulation No. 8 - Lighting of Structures to Minimize Effects to Spectacled and Steller's Eiders. The Biological Opinion for Sale 186 issued by the Fish and Wildlife Service on October 23, 2002, specifies a reasonable and prudent measure necessary and appropriate to minimize potential adverse impacts to this species. To be exempt from the prohibitions of Section 9 of the Act, MMS must comply with the terms and conditions identified in the Biological Opinion. This stipulation requires all structures to be lighted and/or marked to improve visibility to migrating spectacled and Steller's eider, the minimization of outward radiating light, and the reporting of any injured or killed spectacled or Steller's eider. The MMS and the Fish and Wildlife Service cooperatively will develop lighting requirements and identify where, when, and on what type of structures the requirements should be applied. Specific lighting requirements will be developed by April 1, 2004, at which time the MMS will issue these requirements. The lighting requirements do not apply between October 31 and May 1 of each year, when eiders are not likely to be present.

A lighting strategy will be jointly developed by the MMS and the Fish and Wildlife Service using available information on bird avoidance measures. This strategy will be modified, as appropriate, if significant new information on bird avoidance measures becomes available during activities covered by this consultation. Modification will be developed jointly by the MMS and the Fish and Wildlife Service.

For each of the three sales, 16 standard ITL clauses are evaluated as part of all the alternatives. We have included these ITL clauses in previous Beaufort Sea lease sales, and they were evaluated as part of all action alternatives for all three proposed sales. These ITL clauses provide useful information about other Federal and State rules and regulations that help lower environmental impacts for all three proposed sales. Several ITL clauses that had been adopted in previous sales were not included, because they provided outdated information or they have been superseded by other regulations.

An optional ITL clause, No. 17 - Information to Lessees on Archaeology and Geological Hazards Reports and Surveys, lists the particular blocks where lessees will be required to perform surveys and prepare archaeological reports for exploration and development plans. The ITL clause informs the lessee that the shallow-hazards reports, as required in 30 CFR 250.203(b)(1)(ix), and the archaeology report, as required in 30 CFR 250.194 for the blocks listed, are required to be submitted with exploration or development and production plans. This ITL clause is described in Section II.H.4 of the EIS.

ES.1.h Use of the "Opportunity Index" in Considering Alternatives and Mitigating Measures

The locations of future commercial offshore fields that are undiscovered at present are impossible to predict without exploration drilling. Petroleum-assessment models statistically analyze the geology and engineering characteristics of the area to determine the total resource volume that is expected to be economically viable to produce if discovered. While these total resource estimates are valid on a regional scale, they cannot be subdivided into smaller fractions and still be meaningful as real volumes of oil. However, a risk-weighting method can be used to define the chance that the resource volume will occur in a particular subarea.

We use the term "opportunity index" to describe that risk-weighted probability. To understand the index, suppose for example, that an OCS area contained a total of 500 million barrels of economically recoverable oil in any of five prospects. Also suppose that each prospect is the same size and equally likely to contain recoverable oil. The risk-weighted volume assigned to each prospect would be 100 million barrels. The opportunity index assigned to each prospect would be 20%. This means that there is a 20% chance (or 1-in-5 chance) that 500 million barrels could be discovered in any single prospect, but the others would be dry. If a deferral option removed two of the five prospects, we would not subtract 200 million barrels from the total but would lose 40% of the opportunity to discover the 500 million barrels.

The opportunity index is defined by outputs from geologic and economic assessment models based on currently available data. These models assume that leasing, exploration, and development are unrestricted by regulations or industry funding. In reality, access to untested tracts and exploration budgets are key determinants of the level of industry interest in an area. Oil prices and Government regulations also are key determinants. Low oil prices and overly restrictive regulations could lessen industry interest in an area despite its high geologic potential. Future oil prices are difficult to foresee, and future corporate strategies for leasing are impossible to accurately predict. We can base our analysis of resource potential only on past leasing trends and petroleum assessments using current data. Each company may have a very different perspective of the development potential of a frontier area such as the Beaufort Sea. The key concept is that industry will only bid on tracts that they believe have some chance of becoming viable oil fields.

Notwithstanding the value of the opportunity index in understanding how to think about the likelihood of finding oil and gas resources, we caution the reader to exercise care in drawing conclusions about the opportunity index in relation to the aforementioned Alternatives III through VI.

Citation

Richardson, J.W., and D.H. Thomson. 2002. Email dated April 25 to S. Treacy, USDOI, MMS, Alaska OCS Region; subject: results of the bowhead whale feeding study.

TABLE OF CONTENTS

TABLE OF CONTENTS

VOLUME I

VOLUME II

VOLUME III

Figure Number **Title**

Section III

Appendix C: Endangered Species Act, Section 7, Consultation and Coordination (Continued)

MMS memorandum dated May 9, 2002 requesting formal consultation with USFWS under the ESA, and forwarding the Draft EIS for the Proposed Beaufort Sea Multiple-Sale Oil and Gas Lease Sales.

USFWS memorandum dated October 22, 2002 forwarding the Biological Opinion for Sale 186.

MMS letter dated January 7, 2002 sending listed species for Proposed Beaufort Sea Multiple-Sale Oil and Gas Lease Sales to NMFS.

NMFS letter response dated February 11, 2002 indicating that they recently revised the Arctic Regional Biological Opinion in May 2001.

MMS letter dated May 9, 2002 requesting formal consultation with NMFS under the ESA, forwarding the Draft EIS for the Proposed Beaufort Sea Multiple-Sale Oil and Gas Leasing Sales, and inquiring as to the status of May 2001 NMFS Biological Opinion in light of the Proposed Beaufort Sea Multiple-Sale Oil and Gas Lease Sales.

NMFS letter response dated July 23, 2002 to MMS saying that the previous May 2001 Biological Opinion was relevant to the Proposed Beaufort Sea Multiple-Sale Oil and Gas Lease Sales. This consultation is applicable to Sale 186.

Appendix D: Applicable Federal Laws, Regulatory Responsibilities, Executive Orders, and Mitigation Measures

A. Federal Laws and Regulator Responsibilities
B. Executive Orders
C. Mitigation Measures

Appendix E: Scoping Report: Beaufort Sea Proposed Oil and Gas Lease Sales 186 (2002), 195 (2005), and 202 (2007)

A. Introduction
B. Summary of the Scoping Process
C. Environmental Consequences
D. Alternative Recommended for Inclusion in the EIS
E. Alternatives Not Selected for Inclusion in the EIS
F. Mitigating Measures

Appendix F: Exploration and Development Scenarios

A. Multiple-Sale Methodology
B. Individual Sale Scenarios
C. Estimates of Muds and Cutting for Sales 186, 195, and 202
D. Changes in Activities Because of Area Deferrals

Appendix G: Essential Fish Habitat: Consultation and Coordination

MMS letter dated June 20, 2002 to NMFS requesting consultation for Essential Fish Habitat (EFH) for Amendment 5 to the Fishery Management Plan for the Salmon Fisheries in the Environmental Economic Zone (EEZ) off the Coast of Alaska.

NOAA letter dated September 6, 2002 to MMS forwarding comments on the Draft EIS. EFH comment on bottom of page 3, top of page 4.

Appendix H: Information About DEIS Commenters

A. FR Notice of June 19, 2002
B. Listing of Letters Received by Date
C. Public Hearing Attendees
D. Listing of E-Mail Respondents to DEIS

SECTION I

PURPOSE AND BACKGROUND OF THE PROPOSED ACTION

Contents for Section I

I. Purpose and Background of the Proposed Actions

I.A. Purpose, Need, and Description

The purpose of the proposed Federal actions addressed in this Environmental Impact Statement (EIS) is to offer for lease, in three separate sales, areas on the Beaufort Sea Outer Continental Shelf (OCS) that might contain economically recoverable oil and gas resources. This EIS is the National Environmental Policy Act (NEPA) analysis for the first proposed sale enabling the Minerals Management Service (MMS) to conduct the sale-decision process. For efficiency, and consistent with Executive Order 13212 of May 18, 2001, to expedite energy-related projects, this EIS also will be used as the primary NEPA analysis for the second and third sales. However, separate sale-decision processes will be conducted on each of those sales at later dates. The President's National Energy Policy recommends the continuation of OCS oil and gas leasing on a predictable schedule. Domestic energy production is not expected to rise enough to meet all of the Nation's demand, but an increased domestic energy supply will reduce foreign imports and provide jobs within the United States.

These Federal actions will provide qualified bidders the opportunity to bid on certain blocks in the Beaufort Sea to gain conditional rights to explore, develop, and produce oil and natural gas. The three proposed Federal actions addressed in this EIS are for Alaska Region Beaufort Sea Sales 186, 195, and 202 that are scheduled in the OCS oil- and gas-leasing program for 2002-2007. This EIS is the sole NEPA analysis for Sale 186 and the primary NEPA analysis for Sales 195 and 202. It analyzes the potential environmental impacts in each of the sales, including estimated exploration and development and production activities, on the physical, biological, and human environments.

The OCS Lands Act of 1953 (67 Stat. 462), as amended (43 United States Code [U.S.C.] et seq. (1994)), established Federal jurisdiction over submerged lands on the OCS seaward of the State boundaries. Under the OCS Lands Act, the U.S. Department of the Interior (USDOI) is required to manage the leasing, exploration, development, and production of oil and gas resources on the Federal OCS. The OCS Lands Act sets forth a number of findings and purposes with respect to managing OCS resources. Those principles generally pertain to recognizing national energy needs and related circumstances and addressing them by developing OCS oil and gas resources in a safe and efficient manner that provides for environmental protection, fair and equitable returns to the public, State and local participation in policy and planning decisions, and resolution of conflicts related to other ocean and coastal resources and uses.

The Secretary of the Interior (Secretary) oversees the OCS oil and gas program and is required to balance orderly resource development with protection of the human, biological, and physical environments while simultaneously ensuring that the public receives an equitable return for these resources and that free market competition is maintained. Section 18 of the OCS Lands Act requires receipt of fair market value for OCS oil and gas leases and the rights they convey. The Secretary is empowered to grant leases to the highest qualified responsible bidder(s) on the basis of sealed competitive bids and to formulate such regulations as necessary to carry out the provisions of the OCS Lands Act. The Secretary has designated the MMS as the administrative agency responsible for the mineral leasing of submerged OCS lands and for the supervision of offshore operations after leases are issued.

To date, seven lease sales have been held in the Beaufort Sea Planning Area since 1979 (see Map 16). Thirty exploration wells have been drilled (see Map 17), and the MMS approved a development and production plan for the Northstar Project, which straddles Alaska State and Federal waters. Northstar began production on October 31, 2001. The MMS also received a development and production plan for the Liberty Project, which is wholly located on the Federal OCS. A final EIS was written on the project and published in May 2002. The applicant, BP Exploration (Alaska) Inc. (BPXA), announced that it has put the project on the shelf, pending a re-evaluation of costs but has not as yet officially withdrawn its application, although that may happen.

In the Proposed Final Outer Continental Shelf Oil and Gas Leasing Program 2002-2007 (USDOI, MMS, 2002), the Secretary has scheduled to have three sales in the Alaska OCS Region’s Beaufort Sea Planning Area. Sale 186 is scheduled to be held in 2003, Sale 195 in 2005, and Sale 202 in 2007. In keeping with the 5-year program, the MMS has prepared a single EIS for all three Beaufort Sea sales. The proposed actions analyzed in this EIS are for each of the three scheduled Beaufort Sea sales. Federal regulations allow for several similar proposals to be analyzed in one EIS (40 Code of Federal Regulations [CFR] 1502.4). The resource estimates and scenario information on which this EIS analysis is based are presented as a range of resources and activities that could be associated with each of the three sales. The EIS will be used for decisions on Sale 186. The MMS will prepare an Environmental Assessment or supplemental EIS for Sales 195 and 202. Formal consultation with the public will be initiated for these two sales to obtain input to assist in the determination of whether or not the information and analyses in this EIS are still valid. A sale-specific Information Request will be issued that specifically describes the action for which MMS is requesting input. The sale process for Sale 186 will require a minimum of 2 years to complete. The sale processes for Sales 195 and 202 will be somewhat shorter.

As noted earlier in this section, seven OCS lease sales have been held in the Beaufort Sea Planning Area over the past 2 decades, resulting in the development of one joint State-Federal oil field (Northstar). To encourage leasing and development, the MMS is considering incentives in the form of suspensions of royalties for certain oil-production volumes from new leases. The scenarios generated for environmental analysis in this EIS are optimistic compared to historical trends for two reasons: (1) optimistic development scenarios ensure that the environmental analysis covers the potential effects at the high end of possible petroleum activity levels, and (2) the scenarios also would cover an increase in activities that may occur as a result of royalty-relief incentives if they are approved by the Secretary of the Interior. Without incentives, the proposed OCS sales still could result in leasing and exploration. However, under these conditions, we anticipate minimal industry interest in offshore development because of the marginal economic viability of oil discoveries in difficult locations. With incentives, or with long-term oil prices of $30 per barrel, offshore development activities are more likely to approach the levels shown in Table II.A.1.

On September 19, 2001 (pursuant to 30 CFR 256.23 and 40 CFR 1501.7), the Call for Information and Nominations (Call) and Notice of Intent for Oil and Gas Lease Sales 186, 195, and 202 was published in the *Federal Register* (66 *FR* 48268). Nominations and comments on the Call and comments on the Notice of Intent closed on November 5, 2001. The Call was published to gather preliminary information and nominations from interested parties on oil and gas leasing, exploration, and development and production within the proposed area. This provided an opportunity for the oil industry, governmental organizations, tribal and local governments, environmental groups, the general public, and all other interested parties to comment on areas of interest or special concern in the proposed lease-sale area. The comments received on the Notice of Intent are discussed in Section I.C - Results of the Scoping Process.

The MMS Alaska Regional Director sent a memorandum to the Associate Director, Offshore Minerals Management recommending the area to be analyzed in this EIS. The Area Identification (ID) formally identified the location and extent of the area of study for the EIS. The decision document was sent to the MMS Director on January 7, 2002, and the Area ID announcement for Lease Sale 186 (the first sale under the proposed 5-year program for 2002-2007) was made on January 10, 2002, and included 1,877 whole or partial blocks (about 9.7 million acres, or 3.9 million hectares). This area is located seaward of the State of Alaska submerged-lands boundary and extends from 3 to approximately 25 miles offshore in water depths ranging from approximately 25-120 feet (see Map 1). After further analysis, the scoping report was revised and a decision was made in May 2002 that identified the four alternatives and the mitigating measures to be evaluated in this EIS.

Consistent with Section 102(2)(C) of the NEPA, this final EIS describes the proposed lease sales and the natural and human environments, presented an analysis of potential adverse effects on these environments, described potential mitigating measures to reduce the adverse effects of offshore leasing and development, described alternatives to the proposed Federal actions, and presented a record of consultation and coordination with others during EIS preparation. The draft EIS was filed with the Environmental Protection Agency on June 17, 2002, and its availability was announced in the *Federal Register* (67 *FR* 42253). The MMS announced the availability of the draft EIS in the *Federal Register* (67 *FR* 41730) and through other public media. The public had 90 days to review and comment on the draft EIS. Public hearings were held after release of the draft EIS, and specific dates and locations for public hearings were announced in the *Federal Register* (67 *FR* 41730). The MMS obtained oral and written comments at the hearings from interested members of the public. After receipt and consideration of comments on the draft EIS, the MMS determined the scope of this final EIS.

By regulation and law, the MMS is required to review and analyze the environmental effects of this proposed leasing program. Through the scoping process, we asked for comments and concerns about this proposed program. We have used this information to focus our analysis and to generate reasonable alternatives for analysis. Through the remainder of the process, we will continue to solicit information and suggestions.

We have responded to comments on this draft EIS, both written and oral, in Section VII. This includes letters, public hearings, government-to-government meetings, and from e-mails sent to the MMS e-mail address.

The MMS has identified an agency preferred alternative to be Alternative I, including the standard stipulations and ITL Clauses, plus three additional mitigating measures: Stipulation 7 - Pre-Booming Requirements for Fuel Transfers; Stipulation No. 8 - Lighting of Structures to Minimize Effects to Spectacled and Steller’s Eiders; and ITL No. 17 - Information to Lessees on Archaeological and Geological Hazards Reports**.** Although we have identified an agency-preferred alternative, as required by NEPA Council on Environmental Quality regulations, we will continue to maintain an open mind throughout the final EIS comment period and decision process and we will continue to consider and evaluate comments and all reasonable options.

I.B. List of Legal Mandates

The following list references legal mandates that affect Federal activities proposed on the OCS. These statutes are Federal public laws enacted by Congress and are associated with proposed leasing, exploration, development and production, or other activities that might significantly affect the OCS. This is not intended to be a comprehensive list of all the laws but rather to acquaint the reader with the law. Readers should always consult the entire text of the laws for updated information and additional requirements.

Further information, explanations, or summaries of the following legal mandates and for other legal requirements (executive orders, regulations, agreements, etc.) that directly or indirectly relate to the Department of the Interior, MMS, and other Federal Agencies' regulatory responsibilities for mineral leasing, exploration, and development and production activities on leases located in the submerged lands of the OCS located offshore Alaska may be found in Appendix E of this EIS.

- Submerged Lands Act of 1953 (43 U.S.C. § 1331 et seq.)
- Outer Continental Shelf Lands Act of 1953, as amended (43 U.S.C. § 1331 et seq.)
- National Environmental Policy Act of 1969, as amended (42 U.S.C. § 4321 et seq.), and the Council on Environmental Quality regulations (40 CFR parts 1500 through 1508)
- Alaska National Interest Lands Conservation Act of 1980 (16 U.S.C. § 3101 et seq.)
- Clean Air Act of 1970 and the Clean Air Act Amendments of 1990 (42 U.S.C. § 740 et seq.)
- Federal Water Pollution Control Act of 1972, as amended (33 U.S.C. § 1251 et seq.), and the Clean Water Act of 1977 (91 Stat. 1566)
- Coastal Zone Management Act of 1972, as amended (16 U.S.C. § 1451 et seq.), the Coastal Zone Reauthorization Amendments of 1990 (P.L. No. 101-508), and the Coastal Zone Protection Act of 1996 (P.L. No. 104-150)
- Energy Policy and Conservation Act of 1975 (42 U.S.C. § 6213 et seq.)
- Export Administration Act of 1969 (50 App. U.S.C. 2405(d))
- Marine Mammal Protection Act of 1972, as amended (16 U.S.C. § 1361 et seq.)
- Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. § 703-712)
- International Convention of the Prevention of Pollution from Ships and Marine Plastics
- Pollution Research and Control Act of 1988 (33 U.S.C. § 1901 et seq.)
- Marine Protection, Research, and Sanctuaries Act of 1972, as amended (33 U.S.C. § 1401-1445 and 16 U.S.C.§ 1431-1445)
- National Fishing Enhancement Act of 1984 (33 U.S.C. § 2101 et seq.)
- Magnuson-Stevens Fishery Conservation and Management Act of 1976 (16 U.S.C. § 1801 et seq.)
- Endangered Species Act of 1973, as amended (16 U.S.C. § 1531 et seq.)
- National Historic Preservation Act of 1966, as amended (16 U.S.C. § 470 et seq.)
- Oil Pollution Act of 1990, as amended (33 U.S.C. § 2701 et seq.)
- Rivers and Harbors Appropriation Act of 1899 (33 U.S.C. § 401 et seq.)
- Resource Conservation and Recovery Act of 1976 (42 U.S.C. § 6901 et seq.)
- Ports and Waterways Safety Act of 1972, as amended (33 U.S.C. § 1221 et seq.)
- Merchant Marine Act of 1920 (commonly referred to as the Jones Act) (P.L. 66-261)
- Federal Oil and Gas Royalty Management Act of 1982 (30 U.S.C. § 1701 et seq.)
- Arctic Research and Policy Act of 1984 (15 U.S.C. § 4101 et seq.)
- Executive Order 13212 - Actions to Expedite Energy-Related Projects
- Executive Order 13175 - Consultation and Coordination with Indian Tribal Governments
- Executive Order 13158 - Marine Protected Areas
- Executive Order 12114 - Environmental Effects Abroad
- Executive Order 13112 - Invasive Species
- Executive Order 13007 - Indian Sacred Sites
- Executive Order 12898 - Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

I.C. Results of the Scoping Process

Scoping is defined as "an early and open process for determining the scope of issues to be addressed in an EIS and for identifying the significant issues related to a proposed action" (40 CFR 1501.7). The Notice of Intent published for Oil and Gas Lease Sales 186, 195, and 202 describes the scoping process MMS followed for this EIS. Throughout the scoping process, comments are invited from any interested persons, including affected Federal, State, tribal and local governments; any affected Native groups; conservation groups; and private industry for early identification of the most important issues for analysis in this EIS. Scoping is very important, because it provides those with an interest in the OCS program an early opportunity to participate in the events leading up to the final publication of an EIS and aids the MMS in determining the significant issues and alternatives to be analyzed in an EIS. The intent of scoping is to avoid overlooking important issues that should be analyzed in an EIS. The entire text of the Scoping Report is in Appendix F of this EIS.

In response to the Call/Notice of Intent, nine written comments and/or nominations were received: three companies commented and submitted nomination information, and comments were received from the State of Alaska, Office of the Governor, Division of Governmental Coordination; the North Slope Borough, Offices of the Mayor and the Planning Department Director; the Alaska Eskimo Whaling Commission Director; the City of Wainwright, Office of the Mayor; and a joint letter from the Sierra Club, Arctic Connection, The Wilderness Society, and Greenpeace. The nominations received indicated that different companies had interest in various portions of the sale area and, when considered in total, they cover the entire sale area.

Scoping for this multiple-sale EIS included reviewing the comments received on the Call and Notice of Intent; comments submitted at the scoping meetings; re-evaluation of the issues raised and analyzed in the EIS's for previous Beaufort Sea Planning Area lease sales (Sales BF, 71, 87, 97, 124, 144, and 170); and MMS staff evaluation and input. Scoping comments were used to identify major issues, alternatives to the proposed action, and measures that could mitigate the effects of the proposed Federal actions. Scoping comments were requested from the public through newspaper, radio, and television advertisements in the North Slope Borough communities of Barrow, Nuiqsut, and Kaktovik and in Anchorage. Letters were sent to the Mayor of the North Slope Borough and the Mayors of Barrow, Nuiqsut, and Kaktovik. Scoping meetings were held in 2001 in Nuiqsut (October 16), Barrow (October 18), Kaktovik (October 19), and Anchorage (October 26). Government-to-Government scoping meetings were held with the Native Village of Barrow, the Mayor of the North Slope Borough and the Alaska Eskimo Whaling Commission on October 18, 2001. A Government-to-Government meeting also was held with the Nuiqsut Tribal Council on October 16, 2001. An additional meeting was requested by the Alaska Eskimo Whaling Commission and the Inupiat Community of the Arctic Slope and was held on November 15, 2001. All commenters strongly supported the adoption of the Beaufort Sea Sale 170 mitigating measures in sales covered in this EIS. Environmental justice was discussed with participants on the North Slope, both in the Government-to-Government meetings and with individual participants at the scoping meetings.

While the first phase of scoping is complete, the scoping process will continue through the publication of the final EIS, and additional outreach meetings will be held, as needed, or requested by local communities. The scoping process will continue throughout of the life of the multiple-sale EIS. As each sale analyzed within this document is considered for leasing, the scoping process will be initiated.

I.C.1. Major Issues Considered in the EIS

The major issues analyzed in this EIS are the direct result of concerns raised during the scoping process. Based on these issues, the MMS selected the following resource topics for effects analyses in Section IV.C: water quality; lower trophic-level organisms; fishes; essential fish habitat; endangered and threatened species; marine and coastal birds; marine mammals; terrestrial mammals; vegetation-wetland habitats, economy; subsistence-harvest patterns; sociocultural systems; archaeological resources; land use plans and coastal management programs; air quality; and environmental justice.

Significant Environmental Issues: While many environmental issues were raised in scoping, few significant ones were identified that were not addressed to some degree in the previous Sale 170 final EIS published in February 1998. Since Sale 170, the first offshore development and production island in State and Federal Alaska waters—Northstar—has been built and has come online. Actual offshore development has raised feelings of environmental uncertainty by local residents; many do not trust the engineering designs to overcome known North Slope environmental constraints. Many concerns extend to the Liberty development and production project, which is under review.

The following environmental issues are identified and analyzed in this EIS as important resources, activities, systems, or programs that could be affected by petroleum exploration, development and production, and transportation activities associated with proposed Sales 186, 195, and 202. The cumulative effects of past, present, and future activities on each of these resources, activities, systems, or programs also are analyzed in this EIS.

I.C.1.a. Habitat Disturbance to Marine and Terrestrial Mammals, Fish, and Birds and Alteration of Migration Patterns on Bowhead Whales

Habitat disturbance and alteration could result from both offshore and onshore construction activities associated with the operation of petroleum facilities, depending on the location of activities.

I.C.1.a(1) Habitat Disturbance

Habitat disturbance, including noise, would be associated with air traffic, vessel operations, traffic along gravel and ice roads, marine and over-the-ice seismic activities, offshore drilling, dredging, vessels involved in icebreaking and ice-management operations, and facility construction. The primary concern in all communities and of the North Slope Borough is interference with the bowhead whale hunt. Depending on the type and time of occurrence of potential operations, these habitat disturbances could have short- to long-term, local to regional effects on fishes (particularly anadromous species such as the Arctic cisco), marine and coastal birds, marine mammals, caribou, and endangered and threatened species such as the bowhead whale and spectacled eider, all of which will have an effect on subsistence hunting and fishing. Issues related to the above species will be evaluated with additional NEPA analysis for new projects when they are submitted to the MMS.

I.C.1.a(2) Habitat Alteration

Habitat alteration, including reduction, would be associated with both onshore and offshore construction activities that include the construction of pipelines and ice and gravel roads, dredging-excavation and dumping of dredged material, removal of gravel from onshore sites, and dumping of onshore gravel in offshore locations. Depending on the type, timing, and location of potential operations, they could have short- to long-term, local to regional effects on lower trophic-level organisms; fishes (especially Arctic cisco) and other anadromous species; marine and coastal birds; marine mammals; endangered bowhead whales (especially in the spring lead system and fall-feeding area); caribou; archaeological resources; and subsistence-hunting and -fishing activities because of reduced access to the resources. The MMS does not have the legal authority to mitigate disturbances to wildlife from the routing of an onshore pipeline, but the State of Alaska does.

I.C.1.b. Protection of Inupiat Culture and Way of Life

The Inupiat believe their culture and way of life need to be protected from effects associated with petroleum development. As such, potential activities might lead to social disruption and a change in cultural values through employment changes, further displacement of the subsistence lifestyle by a cash economy, and the alteration of subsistence-harvest patterns as discussed in relation to other significant issues previously noted in this section. The EIS discusses and evaluates sociocultural and health systems of local communities.

I.C.1.c. Effects of Oil Spills

I.C.1.c(1) Contamination and Effects

The Inupiat are concerned that a spill could adversely affect many of the traditional food sources and, thereby, affect the economic and cultural well-being of the North Slope. Resources affected by an oil spill that are crucial to Inupiat subsistence include anadromous fish, such as the Arctic cisco, and various marine and coastal birds. The temporary or permanent elimination of primary subsistence foods would cause North Slope residents to either shift to less-desired subsistence resources or replace them with western foods.

The likelihood of large oil spills is very low. However, in the unlikely event that a large oil spill occurred, it could contaminate the affected marine and coastal environments and, depending on the amount and time of the year, have short- to long-term, local to regional effects on those resources and sociocultural systems in and adjacent to the planning area. Such an oil-spill event could have a significant impact on water quality. In situ burning of spilled oil could affect the air quality of the region for a limited time. Lower trophic-level organisms within the spill area also could be affected. Marine mammals, including endangered and threatened species, such as the bowhead whale, could be affected as they migrate through the Beaufort Sea. The bowhead whale is integral to the continuation and survival of the cultural and subsistence lifestyle of the Inupiat. Both the spectacled eider and the Steller's eider are listed as threatened species and could be affected.

I.C.1.c(2) Fate, Behavior, and Cleanup of Spilled Oil

The fate and behavior of spilled oil in the marine and coastal environments and the capability and effectiveness of spill cleanup are of major concern to local communities. Identified concerns include:

- the availability and adequacy of containment and cleanup technologies, especially during broken-ice conditions;
- the ability to detect and clean up pipeline spills and spills under ice;
- the effects of winds and currents on the transport of spilled oil within ice;
- the removal of oil from contaminated water, sediments, and ice;
- the toxicological properties of fresh and weathering oil; and
- the air pollution that would result from the at-sea evaporation or burning of spilled oil.

This concern has intensified in recent years as industry, in three oil-spill-cleanup drills, has not proven their ability to adequately clean up spilled oil with mechanical equipment in relatively calm environmental conditions in ice-infested waters. Other nonmechanical tactics are available in these conditions.

I.C.1.d. Other Significant Issues

The following discusses other significant issues related to petroleum-development activities that were raised during the scoping process.

I.C.1.d(1) Traditional Knowledge

Incorporation of traditional knowledge in past EIS's, although acknowledged, still does not seem to satisfy those who criticize this aspect. Concern seems to center around not recognizing traditional knowledge on the same level as scientific knowledge. The MMS has cited instances where traditional knowledge is quoted within the EIS text; but critics want to know where traditional knowledge has been a part of the decisionmaking process. Villages seemed to appreciate the fact that MMS has taken the traditional knowledge gathered over the last 25 years of public testimony and put this together on a usable, searchable CD-ROM for local use. The MMS will continue to communicate with the Alaska Eskimo Whaling Commission and whaling captains to gain insight into local conditions. Traditional knowledge (i.e., fish species and subsistence values) will continue to be incorporated into EIS text and provided to MMS decisionmakers.

Furthermore, traditional knowledge does not apply equally to all resource categories described and evaluated in this EIS. Much of the traditional knowledge that is incorporated in our EIS's has been provided by Inupiat Elders and leaders at previous meetings and hearings concerning proposed OCS activities. Traditional knowledge information often is focused on their primary areas of concern: subsistence species (bowhead whales, marine and terrestrial mammals, fish, and birds) and subsistence activities, and their effects on the Native people and their sociocultural systems. Traditional knowledge information also has been provided about ice and icebergs, currents, and other physical aspects of gathering subsistence foods in the harsh arctic environment. This focus of available traditional knowledge is reflected in this EIS. There is far more traditional knowledge information presented in this EIS about bowhead whales and subsistence activities than there is about economics or land use plans. Readers and decisionmakers should not interpret the differences in the levels of traditional knowledge information presented in each resource category to be an indication that Native groups and local inhabitants are not concerned with the potential effects to these resources. Rather, this indicates that the consistent collection of information over the history of Inupiat cultural, and some Western science categories, such as economics and land use plans, have not existed long enough to generate a rich body of traditional information of the sort already available for resources such as ice and bowhead whales.

I.C.1.d(2) Cumulative Effects on Resources and Social Systems

In this EIS, we analyze cumulative effects of oil and gas operations on biological resources (for example, caribou migration restricted in relation to pipeline routes and onshore effects, including fishing in the Colville River) and physical resources and social systems (for example, development impacts to the Inupiat way of life, and loss of access to family ancestral ice cellars in Prudhoe Bay) in and adjacent to the planning area from past, present, and future arctic oil and gas lease sales and other major projects. The MMS still hears criticism about the absence of a detailed database of environmental conditions existing before oil and gas operations occurred on the North Slope. The National Research Council is conducting a 2-year research project on cumulative effects of oil and gas operations on the North Slope. While the results are unavailable for this document, they will be considered in the preparation of future NEPA documents.

I.C.1.d(3) Include All Sale 170 Mitigating Measures

All of the mitigating measures, stipulations, and notices to lessees from the last lease sale (Sale 170) should be incorporated into this Beaufort Sea multiple-sale EIS.

I.C.1.e. Issues Raised During Scoping that Were Considered but Did Not Warrant Further Detailed Analysis in the EIS

The following issues were raised during the scoping process for this sale and previous Beaufort Sea lease sales. These concerns were fully evaluated by MMS staff but are not being analyzed further for the reasons indicated.

I.C.1.e(1) Revenue Sharing/Impact Assistance

One primary and repeated request of the North Slope Borough and all of the North Slope villages is the need for revenue sharing (also known as impact assistance) to local communities from OCS receipts. Impact assistance would require congressional action to authorize funds in any particular year.

In its September 20, 2002, comments on the draft EIS, the Alaska Eskimo Whaling Commission asked that the MMS “include mitigation impact assistance in its list of proposed alternatives.” The Commission noted that MMS’s reasons for rejecting their request for impact funding was that the MMS claims that it has no authority to do so. They correctly state that “an alternative need not be in the agency’s cognizance in order for the agency to include it in the EIS.” They also state that: “MMS’s inclusion of impact assistance in its discussion of alternatives would alert the President and Congress to the need for impact assistance in northern Alaska.”

The MMS has not included impact assistance as an alternative for this EIS, because it addresses mitigation of the effects of the proposed action rather than serve as an alternative to the size, timing, or location of the proposed action. The MMS believes that issues relating to size, timing, or location are most appropriate for consideration as separate alternatives. However, the MMS has fully considered the issue of impact assistance as herein discussed.

Impact assistance is a programmatic issue that affects all the states, counties (boroughs), cities, and villages near OCS activities, and it was discussed in MMS's new 5-year plan. Comments received on impact assistance were included within the material forwarded to the President and Congress in the *Proposed Final Outer Continental Shelf Oil and Gas Leasing Program 2002-2007, April 2002*. This programmatic document was the more appropriate forum to address this nationwide issue. For additional information about revenue sharing, please see, in particular, Section 1.2.5.1 of the final EIS for the 5-year program (USDOI, MMS, 2002a).

Congress has been aware of the issue. Impact assistance with a single-year appropriation for FY 2001–The Coastal Assistance Program–was enacted by Congress. This legislation had its impact assistance roots in a broader Congressional bill, the Conservation and Reinvestment Act, which was not enacted. The Coastal Assistance Program was passed as a compromise measure that amended the OCS Lands Act. The program authorized a one-time appropriation of $150 million divided among the seven states with offshore oil activities: Alabama, Alaska, California, Florida, Louisiana, Mississippi, and Texas. Sixty-percent of the funds were divided equally among the producing states, and 40% was based on proximity to OCS production. Based on the law's formula, Alaska received a one-time appropriation of $12,208,723, of which $7,935,670 was allocated to the State and $4,273,053 was divided among the coastal political subdivisions. Funds were distributed to eligible communities based on population, coastline miles, and relative distance from any OCS leased tracts. The allocation for the North Slope Borough was $1,939,680. The National Oceanic and Atmospheric Administration (NOAA) administered the Coastal Assistance Program.

The Department of the Interior and the MMS have taken an active role in impact-assistance proposals. When requested by Congressional members or the Administration, staff has prepared information and support for proposed legislation going back to at least the late 1970's. This included participation on an Administration Cabinet Council task force on impact assistance in the early 1980's and developing a formula and drafting legislative language to provide funds allocated to both the coastal states and local coastal governments based on their proximity to offshore oil and gas activities. Legislation was introduced; however, it passed only in the House.

Throughout the 1980's and 1990's, the MMS continued working diligently on impact-assistance efforts requested by Congress. Congress used the proximity formula as the core of the impact-assistance formula and drafted additional legislative language for several bills that were introduced. These initiatives, however, also failed to become law. Finally, the original proximity concept was the key part of the Coastal Impact Assistance Program legislation, supported by members of the Alaska Congressional delegation that provided FY 2001 funds directly to the North Slope Borough.

Several forms of revenue-sharing-type funds already are available to coastal states and localities through several existing laws: Section 8(g) of the OCS Lands Act, the Land and Water Conservation Fund, the Historic Preservation Fund, and the Tribal Preservation Fund. Because other agencies handle distribution of several of these funds, the public usually is not aware that the funding source for several of these programs comes from OCS-related income.

Section 8(g) of the OCS Lands Act provides for a sharing of all Federal revenues for areas lying wholly or in part within the 3-mile wide area between the State's seaward boundary, which is 3 miles from shore, out to 6 miles. Twenty-seven percent of all Federal revenue goes to the State of Alaska. Alaska has received more than $520 million as a result of this revenue-sharing provision. The State of Alaska distributes percentages of these 8(g) funds (royalty payments, bonus bids, and rental payments) into the Alaska Permanent Fund Dividend Program, its school fund, the Alaska Constitutional Budget Reserve, and Alaska's Unrestricted General Fund

The Land and Water Conservation Fund can provide the National Park Service up to $900 million in the fund each year, if authorized by Congress. Since 1971, Federal offshore leasing has provided about 90% of this money. The law provides for a system of funding for Federal, State, and local parks and conservation areas. It gives states and local governments incentives to plan and invest in their own park and recreational use systems. The State has received more than $29 million from this fund.

The Historic Preservation Fund also is used to make grants to local communities. Revenues from Federal offshore mineral leases sustain this fund up to $150 million, if authorized by Congress. Since 1968, more than $1 billion in grant funds have been awarded to states, territories, tribal organizations, and the National Trust for Historic Preservation. The State of Alaska has received more than $9 million from this fund.

The Tribal Preservation Program, administered by the National Park Service, assists Native Americans in preserving their historic properties and cultural traditions. The program is dedicated to working with tribes, Alaska Native groups, Native Hawaiians, and national organizations to preserve and protect resources and traditions that are of importance to Native Americans. For FY 2000, the Village of Barrow received $48,915 from this grant program for *Documenting Commercial Whaling History in the Western Arctic from the Inupiat Perspective*.

Impact-assistance mitigation, if enacted by Congress, would help MMS further meet the intent of the Environmental Justice Executive Order (Presidential Executive Order 12898) with respect to the effect of the OCS oil and gas program on the Native populations of Alaska. However, as noted above and in the Scoping Report (Appendix E), the Department does not have the authority to fund such an alternative or mitigation for any or all of these three sales or for any OCS sales without authorization from Congress.

I.C.1.e(2) Participation of Local Communities

The need for active participation and involvement, including decisionmaking authority, of the North Slope Borough and local communities was another issue raised at each of the scoping meetings. Examples are Borough, City, and Native village participation in reviewing oil-industry operations, developing monitoring programs, and helping write the various NEPA documents. Locals would like to be brought to Anchorage and be a part of the internal review process of industry-submitted projects. The MMS will continue to engage local governments and tribes in Government-to-Government meetings to share information and discuss potential solutions.

I.C.1.e(3) Global Climate Change

Global climate change and the contribution OCS activities make to greenhouse gas emissions are more appropriately addressed as a programmatic concern in Section 4.1.2 of the Final Environmental Impact Statement for the Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007. This is in accordance with the recommendation of the Council of Environmental Quality, Draft Guidance Regarding Consideration of Global Climate Change in Environmental documents Prepared Pursuant to the National Environmental Policy Act, October 8, 1997, that this issue be addressed at the program level rather than at the project level. The final EIS estimated total emissions of carbon dioxide and methane for activities associated the 5-year program. In the Alaska OCS Region, estimates indicate that production activities could emit about 75% of the carbon dioxide emissions, while tankers carrying Alaska North Slope crude between Valdez and the West Coast contribute about 10% to the total. Tankers produce most of the methane emissions, with the remainder coming primarily from production facilities. The combined carbon dioxide and methane emissions from the entire proposed OCS 5-year program, including the Alaska region, are about 0.04-0.08% of the nationwide total. The estimated combined carbon dioxide and methane emissions from the entire OCS program activities would be about 0.01-0.02% of the global emissions.

I.C.1.e(4) Process Issues

Commenters suggested that areas deferred (i.e., bowhead subsistence-hunt areas) or deleted from past Beaufort Sea sales should be removed permanently from consideration for leasing. The EIS looks at deferring areas for each of the three sales evaluated in this EIS. The Secretary decides whether to offer for leasing or to continue to exclude areas on a sale-by-sale basis. The proposed actions for this EIS are to conduct three sales in the Beaufort Sea: Sale 186 in 2003, Sale 195 in 2005, and Sale 202 in 2007. The EIS will enable the MMS to conduct the prelease decision processes for Sales 195 and 202 more efficiently, consistent with Executive Order 13212 of May 18, 2001, to expedite energy-related projects.

Federal NEPA regulations allow several similar proposals to be analyzed in one EIS (40 CFR 1502.4). The requirements of NEPA, the Coastal Zone Management Act, and all other applicable statutes will be met for all three Beaufort Sea sales.

A suggestion was made that MMS have industry provide job opportunities and training for local communities to help their economy. Under a prelease- or postlease-sale EIS, the MMS does look at and evaluate the local community in relation to the proposed action. However, the MMS has no authority to require an operator to provide local hire. We can and do suggest this to industry, but we cannot enforce such a suggestion. We understand industry does do some local hiring.

Some scoping commenters suggested that a continuum or momentum exists between leasing, exploration, and eventual production and development phases of the Federal oil- and gas-leasing program. Their perception is that once the leasing process begins, it is not stoppable until an oil and gas facility is in place. The OCS Lands Act and the regulations consider these as four separate phases, each of which has a separate decision process attached to that phase. Therefore, four NEPA documents are prepared for these various phases: (1) a national 5-year leasing program; (2) a lease sale for a specific planning area; (3) an exploration plan; and (4) a production and development plan. Each NEPA phase has a different level of analysis, depending on the specificity of the information being submitted for review.

I.C.1.e(5) Other Cumulative Activities

One commenter to the draft EIS suggested the cumulative analysis consider and evaluate military operations; cleanup of abandoned, contaminated sites; research operations (especially icebreaker supported); and other activities taking place on the North Slope and Beaufort Sea. Information about future military operations is limited and the current level of military operations and cleanup activities of abandoned sites onshore have not translated to measurable effects. The more extensive spatial and temporal parameters of the cumulative case tend obscure any minor changes from such activities. There is very little information about potential research using icebreaker support, and we are unaware of any information indicating such activities would occur on a regular basis or pose any major environmental impact to the resources on the North Slope. Normally, all research activities must comply with the Endangered Species Act and the Marine Mammal Protection Act; hence these effects would be minimal.

I.C.2. Alternatives Suggested During the Scoping Process

I.C.2.a. Alternatives to be Further Evaluated

The following six Alternatives are considered in this EIS for Sales 186, 195, and 202:
- Alternative I, the Proposal
- Alternative II, No Lease Sale
- Alternative III, Barrow Subsistence Whaling Deferral
- Alternative IV, Nuiqsut Subsistence Whaling Deferral
- Alternative V, Kaktovik Subsistence Whaling Deferral
- Alternative VI, Eastern Deferral

These alternatives (see Map 2) were developed during the scoping process in response to comments and concerns and further refined by MMS decisionmakers.

I.C.2.a(1) Alternative I - The Proposal

Alternative I, the Proposal for each sale, would offer for lease those blocks selected as a result of the Area ID. The Beaufort Sea multiple-sale program area includes 1,877 whole or partial blocks covering 9,770,000 acres (about 3,954,000 hectares) in the Beaufort Sea (see Maps 1 and 2). This alternative reflects a range of resource development and activity from 340-570 million barrels of recoverable oil for each sale. For purposes of analysis, we assume that 460 million barrels of oil will be recovered as a result of each sale. The program area was identified as being of high and medium interest to industry and is the entire area of the Call. In January 2002, the acting Director of MMS designated the program area to be the area that would be considered for leasing through the Proposal. The Area ID process for Sales 195 and 202 will take place later; however, the aerial extent selected cannot be larger than the area evaluated in Alternative I of this EIS. Because the proposed sale area (Alternative I) is the same as the entire Beaufort Sea program area in the 2002-2007 5-year program, the sale area cannot be larger unless the 5-year program is amended. For this to happen, a new 5-year program would need to be initiated and evaluated, which is very unlikely to happen.

I.C.2.a(2) Alternative II - No Sale

This alternative would remove the entire area of the Proposal from leasing.

I.C.2.a(3) Alternative III - Barrow Subsistence Whaling Deferral

This alternative was developed by the MMS in response to comments received in Barrow. This deferral was developed as a potential way to reduce conflicts between bowhead whale subsistence hunters and offshore oil and gas operations and was based on bowhead whale-strike data provided by the Alaska Eskimo Whaling Commission. This alternative would offer for leasing all of the area described for Alternative I except for a subarea located in the western portion of the proposed sale area. Alternative III would offer 1,851 whole or partial blocks, comprising 9,632,000 acres (about 3,898,000 hectares). The areas that would be removed by the Barrow Subsistence Whaling Deferral (see Map 2) consist of 26 whole or partial blocks, approximately 138,000 acres, about 1% of the Alternative I area. This option is being analyzed to estimate potential protection of Barrow subsistence-use zones and wildlife areas, particularly comprising an area in which whales have been taken (based on known whale-strike data). This option analyzes whether the deferral would provide increased protection to bowhead whales from potential noise and disturbance from exploration or development and production activities. The majority of the bowhead whale subsistence-hunting area near Barrow is in an area of the Chukchi Sea, which already was removed from leasing consideration in the proposed final 5-Year Offshore Oil and Gas Leasing Program for 2002-2007.

I.C.2.a(4) Alternative IV - Nuiqsut Subsistence Whaling Deferral

This alternative would offer for leasing all of the area described for Alternative I except for a subarea located off of Cross Island. Alternative IV would offer 1,847 whole or partial blocks, comprising 9,608,000 acres (about 3,888,000 hectares). The areas that would be removed by the Nuiqsut Subsistence Whaling Deferral (see Map 2) consist of 30 whole or partial blocks, approximately 162,000 acres, about 2% of the Alternative I area. This option is being analyzed to assess the effectiveness of potential protection of Nuiqsut subsistence-use zones and wildlife areas where whales have been taken (based on known whale-strike data). Requests for such possible protection were made by the Alaska Eskimo Whaling Commission, the Native Village of Nuiqsut, and the North Slope Borough.

I.C.2.a(5) Alternative V - Kaktovik Subsistence Whaling Deferral

This alternative would offer for leasing all of the area described for Alternative I except for a subarea located off of Barter Island. Alternative V would offer 1,849 whole or partial blocks comprising 9,649,000 acres (about 3,905,000 hectares). The area that would be removed by the Kaktovik Subsistence Whaling Deferral (see Map 2) consists of 28 whole or partial blocks, approximately 121,000 acres, about 1% of the Alternative I area. This area is being considered for deferral in response to a request by the Native Village of Kaktovik because of the potential disturbance to Kaktovik’s traditional, known subsistence-whaling areas. The area was delineated using whale-strike maps provided by the Alaska Eskimo Whaling Commission.

I.C.2.a(6) Alternative VI - Eastern Deferral

This alternative would offer for leasing all of the area described for Alternative I except for a subarea located east of Kaktovik. Alternative VI would offer 1,817 whole or partial blocks, comprising 9,487,000 acres (about 3,839,000 hectares). The area that would be removed by the Eastern Deferral (see Map 2) consists of 60 whole or partial blocks, approximately 283,000 acres, about 3% of the Alternative I area. It adjoins an area that the State of Alaska has deferred in recent State sales. This option evaluates the need for protection of this area as requested by the Native Village of Kaktovik, the Alaska Eskimo Whaling Commission, and the North Slope Borough regarding the possible importance of the area to bowhead whales and other general concerns about the environment there.

I.C.2.a(7) Agency Preferred Alternative

As required by the National Environmental Policy Act Council on Environmental Quality regulations MMS has identified a preferred Alternative for this Final EIS. The agency preferred alternative is Alternative I, which includes the standard stipulations and ITL clauses, with three optional mitigating measures: Stipulation 7 - Pre-Booming Requirements for Fuel Transfers; Stipulation No. 8 - Lighting of Structures to Minimize Effects to Spectacled and Steller's Eiders; and ITL No. 17 - Information to Lessees on Archaeological and Geological Hazards Reports.

We do not provide a separate evaluation of this alternative because it would repeat the entire analysis provided in Alternative I (See Section IV.C) which includes analysis of the effectiveness of all standard and optional mitigating measures, including those chosen as part of the agency preferred alternative.

Although we have identified an agency preferred alternative, we will continue to maintain an open mind throughout the final EIS comment period and decision process and we will continue to consider and evaluate comments and all reasonable options.

I.C.2.b. Alternatives Considered but not Included for Further Analysis

Four general areas in the Beaufort Sea were recommended for deferral in comments to the September 19, 2001, Call and Notice of Intent and in the October and November 2001 scoping meetings. These were areas east of Barrow, areas around and to the east of Cross Island, areas near Kaktovik, and areas off the Arctic National Wildlife Refuge. The deferrals analyzed in the draft EIS (see Section III of the Scoping Report) respond to some of the specific deferral recommendations. This section responds to the balance of the deferral recommendations. In the following, we first discuss areas recommended for deferral and our conclusions regarding those deferrals for specific parts of the Beaufort Sea. Then we look at other considerations relevant to these recommendations. Finally, we provide the rationale for our conclusion on which recommended deferrals are analyzed in the EIS and which are scoped out.

I.C.2.b(1) Areas from Barrow East to Harrison Bay

In written comments, (See Appendix E, Section B.1, Scoping Report) the State of Alaska supports all areas deferred from past sales, the Mayor of the North Slope Borough and the Sierra Club et al., recommended that such deferrals be removed permanently from leasing in the planning area. The Mayor also recommended that the spring lead system and eastern Beaufort Sea should be deferred from all Beaufort Sea sales in the 2002-2007 offshore leasing program. The Alaska Eskimo Whaling Commission recommended that areas used for the bowhead whale subsistence hunt be removed permanently from any future consideration for OCS leasing. Phillips Alaska Exploration opposed discretionary deferrals and arbitrary exclusions, Shell Oil supported leasing the entire nearshore area out to about 15 miles, and BPXA endorsed the sale schedule but did not comment on specific areas of the Beaufort Sea. In verbal comments at the Barrow meeting with the North Slope Borough and the Alaska Eskimo Whaling Commission, those who spoke wanted MMS to permanently remove from leasing important subsistence-use areas, such as the spring lead system and areas that might be used by bowhead whales for feeding. In the November meetings, the Alaska Eskimo Whaling Commission provided maps of potential deferral areas that were developed by the Barrow and Nuiqsut Whaling Captains, and the Inupiat Community of the Arctic Slope stated their general opposition to all OCS drilling in the Beaufort Sea.

Although it is not the deferral area included in the Barrow Whaling Captains' map, we are analyzing the Barrow Subsistence Whaling Deferral on the western edge of the planning area that, although much smaller (26 versus 588 whole or partial blocks), is based on whale-strike data provided by the Alaska Eskimo Whaling Commission. Also, in response to requests by Barrow residents, the North Slope Borough, and the Alaska Eskimo Whaling Commission, the Secretary removed other areas. Specifically, in her decision on the 5-Year proposed final program, she removed from leasing consideration portions of the subsistence-use area/spring lead system to the west of this deferral area in the westernmost part of the Beaufort Sea Planning Area, and the subsistence-use area/spring lead system in the Chukchi Sea.

Preliminary oil-field analysis of the Beaufort Sea Planning Area indicates that the 588 whole or partial blocks depicted as a candidate for deferral on the map submitted by the Alaska Eskimo Whaling Commission would reduce, by an estimated 18%, the opportunity of discovering and developing an economic oil field, if Alternative I were chosen for one of the three Beaufort Sea sales covered by this EIS. This compares to an estimated reduction of about 1% for the Barrow Subsistence Whaling Deferral.

II.C.2.b(2) Areas Around and East of Cross Island

In written scoping comments (see Appendix E, Section B.1 - Scoping Report) applicable to Nuiqsut subsistence whaling, in addition to what appears for Barrow, the State of Alaska recommended that MMS apply a Cross Island Stipulation (No siting of Permanent Facilities within 10 Miles of Cross Island). The Mayor of the North Slope Borough believed this 10-mile distance is arbitrary and too small, and the area should be expanded to cover various aspects of the Nuiqsut traditional bowhead whale harvest and expanded more to the east to prevent the potential for whales to deflect due to production noise. The people of Nuiqsut want the Cross Island area permanently dropped from leasing consideration.

Although it is not the deferral recommended by the Nuiqsut Whaling Captains, we do include analysis of a smaller Nuiqsut Subsistence Whaling Deferral (30 versus 94 whole and partial blocks) that is based on whale-strike data provided by the Alaska Eskimo Whaling Commission. This deferral option does include some blocks to the east of the 10-mile radius. We also analyze two versions of the no-surface-occupancy stipulation for Cross Island, one for seaward portions of the 10-mile radius area and one for shoreward portions. Furthermore, access to tracts in the vicinity of Cross Island may be needed, because the State has leased tracts in the adjacent State waters. Should oil be discovered on these State tracts, leasing of the adjacent Federal tracts would prevent drainage of Federal oil.

Regarding production noise from permanent industrial facilities on the OCS, companies will be required to demonstrate to the National Marine Fisheries Service that any such proposed facilities will be in compliance with the Marine Mammal Protection Act and Endangered Species Act as they seek to obtain incidental harassment authorizations and avoid conflicts with subsistence activities.

The 94 whole or partial blocks depicted as a candidate for deferral on the map developed by the Nuiqsut Whaling Captains would reduce, by an estimated 19%, the opportunity of discovering and developing an economic oil field. This compares to an estimated reduction of about 2% for the Nuiqsut Subsistence Whaling Deferral.

I.C.2.b(3) Areas that are Offshore from the Arctic National Wildlife Refuge

In scoping comments for this EIS, the Mayor of the North Slope Borough said that the eastern Beaufort Sea should be deferred from all three sales in the 2002-2007 leasing program. In comments on the 5-year offshore leasing program, the Mayor of the City of Kaktovik expressed a preference for onshore development, recommended that the area off of the Arctic National Wildlife Refuge be excluded from leasing until the Refuge is opened for development, and that all OCS blocks within 50 miles of the city be excluded. Citing these comments from Kaktovik, the Sierra Club et al. said in their scoping comments for this EIS that they supported the City of Kaktovik’s request for a deferral area offshore from the Canning River to the Canadian border. This area includes 173 whole or partial blocks. Deferring it would reduce, by an estimated 23%, the opportunity of discovering and developing an economic oil field. The deferrals in Alternatives V (Kaktovik Subsistence Whaling Deferral) and VI (Eastern Deferral) cover 88 of these same blocks and run offshore of about 60% of the coastline of the Arctic National Wildlife Refuge. The selection of Alternatives V or VI would reduce, by an estimated 3% each, the opportunity of discovering and developing an economic oil field.

Although no prohibition on offshore leasing is included in the statutes governing the Arctic National Wildlife Refuge, its Comprehensive Management Plan restricts the use of the Refuge for infrastructure to support any offshore development. Also, any OCS activity or infrastructure (including pipelines to shore) would not be approved without thorough technical and environmental reviews and would have to meet the requirements of the Marine Mammal Protection Act, the Endangered Species Act, and other Federal and State statutes that help protect the natural resources of the area and environment.

The Kaktovik Whaling Captains did not submit a map but indicated that they wanted the area known as the "Barter Island" deferral from Sales 124 and 144 as a deferral for these three sales. The northern part of the "Barter Island" deferral from OCS Sale 144 is excluded from the proposed final 5-year offshore program. Alternative V, the Kaktovik Subsistence Whaling Deferral, includes the Sale 144 deferral area plus a few extra blocks on the west side to more fully cover the area where Alaska Eskimo Whaling Commission data shows whale strikes were made.

I.C.2.b(4) Other Considerations Relevant to Requests for Deferrals Off Barrow, Cross Island, and the Arctic National Wildlife Refuge

There are five standard stipulations (see Section I.C.3) included as part of all deferral alternatives for Sales 186, 195, and 202. These are mitigating measures that will help protect the bowhead whale. The first four stipulations provide for specific protections, and the fifth is a mechanism to address unresolved conflicts between the oil and gas industry and subsistence activities. This mechanism has proven to be effective in protecting the whale hunt while allowing oil and gas activity to proceed. The mechanism can apply to whatever unreasonable subsistence-related conflicts are not resolved by other means. We also are including a possible addition to a notice of Information to Lessees (ITL) clause (ITL 7 - Information on the Availability of Bowhead Whales for Subsistence-Hunting Activities) indicating that for development plans, lessees are encouraged to consider noise-abatement methods, if needed, to reduce activity noise that may occur during and in the vicinity of the migration.

I.C.2.b(5) Rationale for Conclusions on These Three Recommended Deferrals

A primary objective of the OCS Lands Act is to make lands available for oil and gas leasing in an environmentally acceptable manner, taking into consideration protection of the marine, coastal, and human environments. An objective we undertake to meet NEPA requirements is to write an EIS that is as straightforward and as easy to understand as possible, given the inherent difficulty in estimating uncertain potential environmental effects of uncertain potential exploration and development activities based on projections of uncertain potential leasing results of planned future sales. Given the four deferral alternatives already included for analysis, these three deferral options would contribute little in the way of additional analysis to an EIS that must cover an already complicated set of issues.

We consider that the Barrow, Nuiqsut, and Kaktovik Subsistence Whaling Deferral alternatives, when combined with the other mitigating measures (stipulations and ITL clauses) to be analyzed in the EIS, would provide about the same level of protection of the environment as the preceding three recommended deferral areas, but they would allow at least some oil and gas exploration and development to proceed. Regarding the Arctic National Wildlife Refuge, we believe that the merits of including such a deferral option are in large part covered by analysis of Alternatives V and VI.

Furthermore, the analyses of six alternatives (Proposal, No Action, and four deferral alternatives), and the mitigating measures cited above for the bowhead whale subsistence hunting and other natural resources possibly affected by offshore exploration and development, meet NEPA requirements and provide alternatives that achieve the objectives of the OCS Lands Act.

I.C.3. Mitigating Measures

I.C.3.a. Mitigating Measures Suggested During the Scoping Process

The following standard mitigating measures have been adopted in our most recent sales in the Beaufort Sea and will be considered and evaluated as part of the Proposal and alternatives for the Beaufort Sea multiple-sale EIS. The effectiveness of these stipulations is evaluated in Section II.H.1.

I.C.3.a(1) Standard Stipulations

All stipulations are considered part of the proposed action and all alternatives.

No. 1 - Protection of Biological Resources
No. 2 - Orientation Program
No. 3 - Transportation of Hydrocarbons
No. 4 - Industry Site-Specific Bowhead Whale-Monitoring Program
No. 5 - Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence Activities

These standard stipulations are described in more detail in Section II.H.1.

I.C.3.a(2) Additional Stipulations for Consideration in the EIS

These additional standard stipulations also are evaluated in the EIS. All of the stipulations are options for consideration in lieu of or in addition to the deferral alternatives or other mitigating measures. We evaluate the inclusion of other stipulations that are developed during the EIS process.

Stipulations 6a and 6b - No Siting of Permanent Facilities in the Vicinity of Cross Island. These potential stipulations were developed to reduce effects and potential conflicts between subsistence whaling activities that occur annually at Cross Island and oil and gas activities that may occur in the same area. The full text for both of these stipulations is provided in Section II.H.2.

For purposes of analysis, the Cross Island stipulation is divided into two parts. Stipulation 6a applies the 10-mile radius around Cross Island outside the barrier islands. Stipulation 6b applies the 10-mile radius to those blocks within the barrier islands (see Map 3).

Stipulation 7 - Pre-Booming Requirements for Fuel Transfers. This potential stipulation requires deployment of oil-spill boom of the fuel barge, if fuel transfers (excluding gasoline transfers) are proposed just prior to and during the whale migration for fuel amounts of 100 barrels or more. This stipulation is applicable to the blocks and migration times listed in Stipulation No. 4 - Industry Site-Specific Bowhead Whale-Monitoring Program. This stipulation was developed to reduce potential adverse effects from diesel fuel, which is very toxic and could adversely affect bowhead whales if such a spill occurred during or just prior to the annual whale migration.

Stipulation No. 8 - Lighting of Structures to Minimize Effects to Spectacled and Steller's Eiders. The Biological Opinion for Sale 186 issued by the FWS on October 23, 2003 specifies a reasonable and prudent measure necessary and appropriate to minimize potential adverse impacts to these species. In order to be exempt from the prohibitions of Section 9 of the Act, MMS must comply with the terms and conditions identified in the Biological Opinion. This stipulation requires all structures to be lighted and/or marked to improve visibility to migrating spectacled and Steller's eider, the minimization of outward radiating light, and the reporting of any injured or killed spectacled or Steller's eider. The lighting requirements do not apply between October 31 and May 1 of each year when eiders are not likely to be present.

A lighting strategy will be jointly developed by the MMS and FWS using available information on bird avoidance measures. This strategy will be modified, as appropriate, if significant new information on bird avoidance measures becomes available during activities covered by this consultation. Modification will be developed jointly by MMS and the FWS.

I.C.3.a(3) Standard ITL Clauses

The following standard ITL clauses (1 through 16) apply to OCS activities in the Beaufort Sea area and are considered part of the proposed action and alternatives for the Beaufort Sea multiple-sale EIS.

No. 1 - Information on Community Participation in Operations Planning
No. 2 - Information on Kaktovikmiut Guide *In this Place*
No. 3 - Information on Nuiqsutmiut Paper
No. 4 - Information on Bird and Marine Mammal Protection
No. 5 - Information to Lessees on River Deltas
No. 6 - Information on Endangered Whales and the MMS Monitoring Program
No. 7 – Information on the Availability of Bowhead Whales for Subsistence-Hunting Activities

No. 8 - Information on High-Resolution Geological and Geophysical Survey Activity
No. 9 - Information on Polar Bear Interaction
No. 10 - Information on the Spectacled Eider and the Steller's Eider
No. 11 - Information on Sensitive Areas to be Considered in Oil-Spill-Contingency Plans
No. 12 - Information on Coastal Zone Management
No. 13 - Information on Navigational Safety
No. 14 - Information on Offshore Pipelines
No. 15 - Information on Discharge of Produced Waters
No. 16 - Information on Use of Existing Pads and Islands

These ITL clauses are described in Section II.H.3.

I.C.3.a(4) Additional ITL Clauses for Consideration in the EIS

The MMS decided it would be useful to information to the public and future lessees to add the following optional ITL clause, No. 17 - Information to Lessees on Archaeology and Geological Hazards Reports and Surveys, lists the blocks where lessees will be required to perform surveys and prepare archaeological reports for exploration and development plans. The ITL informs the lessee that the shallow hazards reports as required in 30 CFR 250.203(b)(1)(ix) and the archaeology report as required in 30 CFR 250.194 for the blocks listed, (See Map 15) are required to be submitted with exploration or development and production plans. This ITL clause is described in Section II.H.4.

I.C.3.b. Mitigating Measures Not Considered in this EIS

During the preparation of the draft EIS, the MMS evaluated the merits of adding an ITL clause to encourage lessees to consider noise-abatement methods, if needed, to reduce activity noise that may occur during and in the vicinity of the whale migration. However, no one commented on the merits of such an ITL, either in the hearings or through written comments. While lessees and operators may choose to incorporate noise-abatement techniques into their facility and equipment designs, the MMS did not find any merit in creating a mitigating measure or requirement at this time. This type of requirement may be considered and evaluated later during the environmental assessment of exploration and development plans.

I.D. Indian Trust Resources

The Federal Government does not recognize the validity of claims of aboriginal title and associated hunting and fishing rights that have been asserted for unspecified portions of the sale area. Therefore, the MMS anticipates that the proposed action or alternatives will have no significant effects on Indian Trust Resources. While the Department of the Interior does not recognize these resources as Indian Trust Resources, this EIS considers the potential effects of lease-sale activities on Native Alaskan communities as they relate to economics, subsistence-harvest patterns, sociocultural systems, and environmental justice. The MMS consults with federally recognized tribes consistent with the Presidential Executive Memorandum dated April 29, 1994, on Government-to-Government Relations with Native American Tribal Governments; Executive Order 13175 dated November 6, 2000, on Consultation and Coordination with Indian Tribal Governments; and the January 18, 2001 Department of the Interior-Alaska Policy on Government-to-Government Relations with Alaska Native Tribes.

MMS attended several government to government meetings in July, coincidental with the time frame for the hearings. Government-to-Government meetings were held with the Native Village of Nuiqsut, Native Village of Barrow, and the Inupiat Community of the Arctic Slope. The MMS contacted the Native Village of Kaktovik requesting a government to government meeting, but they opted to testify at the Public Hearing instead. They said they were too busy to come to two meetings, and, in any case, the same people would come to the public meeting.

Following are the summaries of the meetings as prepared by MMS staff.

I.D.1. Summary of Native Village of Nuiqsut Government-to-Government Meeting

Native Village of Nuiqsut and Community Attendees: Frank K. Long, Jr. (Vice President, Tribal Counsel Member, Native Village of Nuiqsut); Bernice Kaigelak (Treasurer, Native Village of Nuiqsut); Zena Kasak (Tribal Administrator, Native Village of Nuiqsut); Sarah Kunaknana (Tribal Counsel Member, Native Village of Nuiqsut); Eli Nuikapigak (Mayor, Nuiqsut City); Isaac Nukapigak (Tribal Counsel Member, Native Village of Nuiqsut); and James Taalah (Tribal Counsel Member, Native Village of Nuiqsut).

MMS Attendees: Paul Stang (Regional Leasing Supervisor, Anchorage); Renee Orr (Chief, Leasing Division, Herndon); Dr. George Valiulis (Environmental Assessment Division, Herndon); Albert Barros (Community Liaison, Anchorage); and Angela Mazzullo (Budget Analyst, Washington, D.C.). Nathaniel Hile from Computer Matrix Court Reporters from Anchorage also attended the meeting.

Meeting Summary: A meeting was held with representatives of the Native Village of Nuiqsut at 7 p.m. on Tuesday, July 23, 2002, at the Nuiqsut City Hall Building. Subject matter ranged from Government-to-Government concerns to comments on the draft EIS. The Nuiqsut representatives expressed concern over having yet another Federal lease sale in the Beaufort Sea, because they had testified so many times in the past against OCS leasing. They felt that from a safety perspective, drilling in the Beaufort Sea was very dangerous because of historic storms, currents, earthquakes, and ice forces. They were most concerned about an oil spill having a negative effect on their subsistence resources and subsistence lifestyle. They do not want to be run off of Cross Island or have limited access to this location, because this is their main bowhead whaling staging camp site. They expressed frustration in not gaining sufficient industry employment opportunities once a company did drill on the North Slope, and the inability of MMS to secure local funding (impact assistance) for actions taking place in their backyard. Several expressed discrimination by the oil industry against Natives in general, in obtaining jobs and treating them as an equal. They felt that current and past oil and gas operations may be impacting their fish and marine mammal resources as industry infrastructure seem to be displacing once abundant wildlife, with some fish and pinnipeds having unexplained lumps and tumors which they attribute to possible oil and gas activities. They want an EIS for each specific lease sale not one multiple-sale EIS, and they want all the current deferrals to be included and expanded in the final EIS.

The MMS listened to their concerns and explained the current leasing program, giving an overview of the process. The MMS explained the relationship between the 5-year leasing program and the current Beaufort Sea multiple-sale oil and gas leasing effort, displaying maps to outline the sale area and showing the limits of the various alternatives being considered. We explained how the NEPA analysis was being written for three sales under one EIS cover, and that local input will be gathered for an Environmental Assessment at each successive lease sale stage with the option of writing another EIS if changing conditions warranted. We explained that the decision for impact assistance was something granted by Congress and, although MMS has a long history of support for such legislation, funding has been limited in relation to what the locals desire. We asked about the problem of deformed fish and pinnipeds that Nuiqsut residents raised and said that to our knowledge, this is not oil-industry related, but that we have ongoing environmental studies which may be able to shed some more light on this concern. We explained Stipulations 6a and 6b regarding the Cross Island. Several locals described past environmental conditions and wondered how industry could work safely in this type of environment. No big issues were solved; each just listened to the other explain their position either as a local member or as a governmental agency.

I.D.2 Summary of Native Village of Barrow Government-to-Government Meeting

Native Village of Barrow Attendees: Percy Nusunginya (Vice-President, Tribal Counsel Member); James Patkotak (Secretary, Tribal Counsel Member); Ellen Kanayurak (Treasurer, Tribal Counsel Member); Rosabelle Rexford (Tribal Counsel Member); Tommy Olemaun (Sergeant At Arms, Tribal

Counsel Member); Thomas Brower, III (Natural Resources Manager); and Neil Bjornsted (Tribal Grant Writer).

MMS Attendees: Paul Stang (Regional Leasing Supervisor, Anchorage); Fred King (Chief, Environmental Assessment Section, Anchorage); Albert Barros (Community Liaison, Anchorage); and Angela Mazzullo (Budget Analyst, Washington, D.C.).

A meeting was held with representatives of the Native Village of Barrow at a Special Tribal Council Meeting, at 2 p.m. on Thursday, August 1, 2002, at the Native Village of Barrow facilities. We discussed a range of topic subject matter, includes concerns about the Beaufort Sea draft EIS and other ongoing and planned OCS activities. They expressed concerns about having three different lease sales at different times, all under the umbrella of a single EIS. The past EIS's were lease-sale specific, and they did not see the need for a change. They were very concerned about the potential impact of an oil spill upon their Native food resources and lifestyle, if a sale were to go forward. They also asked if sanctuaries or habitat zones were being set aside for each sale. The issue of sanctuaries may have been seen as similar to the proposed lease-sale deferrals.

The MMS apologized for the week's delay in the meeting, but weather prevented us from getting to Barrow, and the attendees said they appreciated the rescheduled meeting. The MMS gave an overview of the 5-year program and how the Beaufort Sea multiple-sale lease sales fit into this mix. The MMS explained through words and maps the various sale schedules and the alternatives and emphasized that the MMS was not proposing marine or wildlife sanctuaries. The MMS explained the multiple-sale EIS process; however, the locals indicated that they still wanted three individual EIS's. We explained the 3-mile State jurisdiction, the MMS OCS jurisdiction, and the International Law of the Sea limits. Some present indicated that through Inupiat law, their lands extended past the shoreline out onto the ice and beyond. The participants from Barrow said they appreciate MMS meeting with the tribal governments; we seem to be the only Federal or State agency that does so before an action actually takes place. We explained that we translated the draft EIS Executive Summary into Inupiat and asked if it was useful. We found out that the translator we used had a different dialect from others in the room and although helpful, it was not quite on target. The group decided that their conversations at this meeting expressed the Native Village of Barrow concerns and they would not be attending the Public Hearing that evening.

I.D.3 Summary of Inupiat Community of the Arctic Slope (ICAS) Government-to-Government Meeting

ICAS Attendees: Arnold Brower, Jr. (President); Doreen Lampe (Treasurer); Delbert Rexford; Bill Tegoseak (Executive Director); Rebecca Brower (Tribal Operations Officer); Ellen Farantz (Finance Director); Carolyn Edwards (Realty); and James Patkotak (Natural Resources Officer). Participating via teleconference: John Hopson, Jr. (Native Village of Wainwright); Billy Nashoalook, Sr. (Native Village of Wainwright); Harry Hugo (Native Village of Anaktuvuk Pass); and Jack Schaeffer (Native Village of Point Hope).

MMS Attendees: Paul Stang (Regional Leasing Supervisor, Anchorage); Fred King (Chief, Environmental Assessment Section, Anchorage); Albert Barros (Community Liaison, Anchorage); and Angela Mazzullo (Budget Analyst, Washington, D.C.).

Meeting Summary: The MMS attended a meeting with participants representing the ICAS in Barrow on Thursday, August 1, 2002, at the North Slope Borough's teleconference center. Subjects ranged from Government-to-Government concerns to comments on the draft EIS. Those attending expressed concerns that other villages along the North Slope–Wainwright, Pt. Lay, and Pt. Hope–were not invited/included in scoping for these proposed lease sales, because they also harvest the bowhead/beluga whales that passed through waters in which oil company operations might influence these species. They also wanted some sort of remuneration (impact-assistance funding) for all the time and travel their staff expended in reviewing EIS documents. They were talking about an annual funding agreement between the MMS and the ICAS. They were recommending a subsistence activity sanctuary and indicated that they may go to court to fight another Beaufort Sea lease sale. The Pt. Hope representative opposed all OCS activities, including seismic, from the Canadian border to Pt. Hope. He felt that OCS activities could be conducted from onshore using slant drilling, so as not to impact subsistence resources, hunting, or harvests. One participant wanted the ICAS Natural Resource Director at village meetings with MMS so that they can hear local views on OCS oil and gas issues.

MMS apologized for having to reschedule this meeting due to weather conditions a week ago, and appreciated the scheduled meeting to talk about any issues ICAS had about government-to-government issues or the draft EIS. We explained through words and maps the 5-year leasing program, the multiple-sale Beaufort Sea leasing program, and how MMS focuses its scoping efforts mainly for those communities adjacent to the actual proposed lease sale area. When a Chukchi Sea sale is considered, the three mentioned villages will be heavily involved in scoping. The MMS explained the various alternatives being considered and how they were arrived at.

The ICAS wanted to know what was included in the discussions at the Nuiqsut and Kaktovik public hearings, and MMS gave them a synopsis. Several participants did not feel that MMS was listening to North Slope residents because for years, they have been voicing opposition to OCS leasing. The MMS said that they have been listening, making adjustments to sale boundaries, and adding alternatives; however, as a Government Agency we still had a mandate to offer OCS acreage for industry leasing. There was some reference to a Canadian meeting in which the Northwest Territory was working directly with the local tribal governments; ICAS wants this same local negotiation for U.S. OCS leasing.

The MMS explained a little bit about the coming Chukchi sales and how that would be coordinated with villages on the Chukchi Sea. The ICAS suggested an annual funding agreement with MMS, so that they can better participate with local meetings; the MMS said that was not provided for under the current regulations. the ICAS wanted to know how the alternatives were chosen, and we explained how we used the whale-strike data as a base to make some boundaries. The ICAS then wanted to know why we have not set aside critical habitat for whales, fish, or birds. We responded that such jurisdiction fell to other agencies' mandates, but we would discuss this with them if they made such a suggestion formally. The ICAS said that they would be sending further comments on this proposed lease sale to MMS. (Note: none were received.). The ICAS gave us a mailing list to send 12 additional draft EIS's to their board members. (Note: This was done when the team got back to the office). The ICAS requested that for future meetings, the MMS provide more advance notification of pending meetings, and what is on the agenda. They also suggested the MMS provide door prizes to get better attendance. Dialog between the MMS and the ICAS was concluded; the MMS listened and responded, but it seemed that ICAS was not satisfied with all the answers received.

I.E. Environmental Justice Executive Order 12898

The Presidential Executive Order on Environmental Justice requires agencies to incorporate environmental justice into their missions by identifying and addressing environmental effects of their proposed programs on minorities and low-income populations and communities. The Department of the Interior has developed guidelines in accordance with Presidential Executive Order 12898. The MMS participated in the development of these guidelines. The MMS's existing process of involving all affected communities and Native American and minority groups in the NEPA-compliance process meets the intent and spirit of the Executive Order. However, we are continuing to identify ways to improve the input from all Alaskan residents, not only by commenting on official documents but also by contributing their knowledge to the scientific and analytical sections of the EIS.

Environmental concerns generally were identified during the scoping process for the Beaufort Sea sales. The potential effects of sale activities on the issues raised by these concerns are addressed in Section IV.C.16 on Environmental Justice.

In the unlikely event of a large accidental oil spill, there is the likelihood for disproportionately high adverse effects on Inupiat subsistence-harvest activities and sociocultural systems. Disproportionate high adverse effects are not expected to occur from routine exploration and development activities. Specific mitigating measures have been developed to address the impacts of exploration and development activities on subsistence activities and subsistence resources, particularly the bowhead whale. By incorporating the stipulations on Subsistence Whaling and other Subsistence Activities and Industry Site-Specific Bowhead Whale-Monitoring Program, impacts from OCS activities on important subsistence resources would be mitigated but not eliminated.

I.F. The National Environmental Policy Act Process for Sales 186, 195, and 202

We are using a different approach in both format and structure for this lease-sale EIS than we used for previous EIS's for the Beaufort Sea area. This section details why and how this difference came about and the advantages we see from this change.

Once a lease sale is held within a particular geographic area, the results of scoping for subsequent lease sales within the next several years tend to reflect industry interest and the comments received on the initial sale in the same area. This initial multiple-sale EIS addresses the concerns expressed by local, State, Federal, and public reviewers and issues addressed within the specific EIS. Additional lease-sale proposals and NEPA documentation covering the same geographic area may further clarify issues; however, much of the text of both comments received and EIS's written repeat the text of previous documents already in the public domain. Over the years, reviewers have expressed reluctance to review and comment on a NEPA document that looks very similar to the one they just reviewed. Indications of industry interest show that in subsequent sales within a geographic area, interest generally declines if exploration is unsuccessful, because the most likely prospects are leased and explored first. This is based on the fact that there have been no big discoveries on the Beaufort Sea OCS. If such a discovery is made as a result of a sale, this trend could reverse.

Preparing the Beaufort Sea multiple-sale EIS does not set a precedent. The MMS Gulf of Mexico Region has been publishing single multiple-sale EIS's for the last two 5-year oil and gas leasing programs. Also, the Northeast National Petroleum Reserve-Alaska EIS, which was completed in August 1998, will be used for more than one sale.

Within the Alaskan Beaufort Sea Planning Area, the MMS Alaska OCS Region has held 7 oil and gas lease sales: Sales BF (1979), 71(1982), 87 (1984), 97 (1987), 124 (1990), 144 (1996), and 170 (1998). In the Beaufort Sea, 688 leases were issued as a result of those sales, and 30 exploration wells were drilled. One development and production project (Northstar) has been approved. A second (Liberty) received NEPA review, and a final EIS was published in May 2002. Although MMS published the Liberty final EIS, the applicant has placed their Development and Production Plan application on hold pending further cost analysis. The Beaufort Sea has been an area of high interest to industry. The NEPA documentation conducted for these lease sales included a draft and final EIS for each action. In addition, a supplemental EIS was written for Sale BF in 1980, and draft and final EIS's for a Proposed Arctic Sand and Gravel Lease Sale were written in 1982 and 1983, making a total of 19 EIS documents written for activities in the Beaufort Sea that are in the public domain.

Although this EIS addresses three proposed sale actions, only one sale decision will be made every other year. This EIS analyzes impacts for Sale 186, which is scheduled for 2003. A Call and Notice of Intent were issued at the beginning of the prelease process to explain the multiple-sale approach for the EIS. The Area ID selected the same area identified in the 5-year program for 2002-2007. Separate Area ID's will be conducted for Sales 195 and 202. They will be equal to or smaller than the area studied in this EIS. A Notice of Sale will be issued for each sale, after completion of the final NEPA document for each sale.

If the Secretary of the Interior decides to proceed with each of the sales (186, 195, and 202), by not choosing Alternative II - No Action, the Secretary may choose one, all, some combination, or part of the deferral options to comprise the final Notice for Sale 186. The Secretary will have the full suite of options available for Sales 195 and 202 when those decisions are made in 2005 and 2007, respectively. The Secretary may choose the same options selected for Sale 186 or different options.

For purposes of analysis, we introduce in this EIS the concept of three geographic/economic zones (Map 4). See Appendix F Exploration and Development Scenarios for a more detailed discussion of this concept. Exploration and development activities under this EIS could take place in any zone from any of the proposed sales. For analysis, we focus on development in the Near and Midrange zones for Sales 186 and 195 and the Far Zone for Sale 202. This is a reasonable scenario given the current infrastructure. If companies buy leases in the Far Zone at Sale 186, resulting exploration and development, if any, likely would be similar to that described for Sale 202. If exploration and development take place in the Midrange and Far zones, the effects likely would be similar to those identified for Sales 195 and 202.

Preparing a multiple-sale EIS enables us to conduct the prelease decision processes for subsequent sales (Sales 195 and 202) more efficiently, consistent with Executive Order 13212 issued on May 18, 2001, to expedite energy-related projects. This EIS incorporates by reference previous EIS's and updates existing text and data, with emphasis on new information since the last EIS was written, and explain the multiple-sale process.

Before starting the process for Sales 195 and 202, the MMS will initiate consultation with the public. An Information Request will be issued, specifically asking for input on the scheduled sale being considered. A NEPA review will be conducted for each subsequent sale. An Environmental Assessment (EA) will be prepared to determine whether or not the information and analyses in this single EIS for multiple-sales are still valid for each subsequent sale under consideration. This EA will focus on new information and/or data since publication of the final Beaufort Sea multiple-sale EIS. Consideration of the EA and any comments received in response to the Information Request will result in either a Finding of No Significant Impact (FONSI) or a determination that a supplemental EIS is warranted.

Because the EA will be prepared for a proposal that "is, or is closely similar to, one which normally requires the preparation of an EIS" (40 CFR 1501.4(e)(2)), a FONSI will be available for public review for 30 days before a decision is made. The EA/FONSI will be sent to the Governor of the State of Alaska, and its availability announced in the *Federal Register*. The FONSI will become part of the Record of Decision prepared for the decision on the Notice of Sale.

If the EA determines additional analysis is needed, we may need to prepare a supplemental EIS (40 CFR 1502.9). Some of the factors that could justify a supplemental EIS are a significant change in resource estimates, significant new information, significant new environmental issue(s), or a significant change in the proposed action. The supplemental EIS will focus on addressing the significant issues and analyses.

I.F.1. Sale 186 Process

This EIS includes an analysis of offering for lease, three different times, the Federal offshore area within the Beaufort Sea Planning Area as defined in the 2002-2007 proposed final 5-year program. The EIS also includes an assessment of alternatives and cumulative effects. The cumulative effects analysis evaluates the contribution of Alternative I for Sale 186 to the past, present, and reasonably foreseeable activities, including State and Federal onshore and offshore activities on the North Slope and in the Beaufort Sea. The two subsequent sales in this 5-year program (Sales 195 and 202) are evaluated as part of those reasonable for foreseeable activities. The cumulative effects of the alternatives for Sale 186 and for Sales 195 and 202 and their alternatives are expected to be essentially the same as those for Alternative I for Sale 186. This is because the potential effects of each sale are based on the same oil and gas resource level; each sale would affect the same physical, biological, and human resources; and each sale is scheduled to occur in the same area within the 5-year period. Slight differences may occur in the contributions to cumulative effects from the various alternatives of the three sales. However, they are so small relative to the overall cumulative effects to which they are being compared, that they cannot be meaningfully measured.

For purposes of analysis, we defined the production volumes expected from leasing in the program area. Anticipated production and associated activities are analyzed based on economic resource estimates established at the beginning of the 2002-2007 5-year program. The EIS analyzes the effects of exploration, development, and production quantitatively to the degree possible, using different economic and development scenarios individually for each sale. Impacts that cannot be estimated quantitatively are estimated qualitatively. The EIS analyses will be used by reference as the basis for the analyses in the EA's or supplemental EIS's prepared for subsequent sales (Sales 195 and 202) in the planning area during the 2002-2007 5-year program.

The description of activities to take place is broad enough to encompass the range of resources and activities expected for any of the three sales. The resource estimates and accompanying scenario information for the area considered for analysis in the EIS is presented as a range of resources and activities based on different economic conditions.

The scenarios cover a range of resources and activities that are likely to result from the proposed actions. The two later sales will be subject to an EA or supplemental EIS. This EIS assumes that standard mitigating measures are in place as part of the Proposal; the EIS assesses the effects of possible new mitigating measures added to existing standard mitigating measures. The effects are analyzed quantitatively (if possible) or qualitatively. Oil-spill-modeling runs were conducted for the program area.

Based on the results of scoping, alternatives are analyzed that defer certain blocks from the sale. Alternatives are evaluated by comparing changes in resource production and environmental effects relative to the entire program area. Alternative I for each sale includes all the blocks in the Beaufort Sea Planning Area, as defined in the 2002-2007 5-year program. The final EIS identifies the agency-preferred alternative.

The MMS resource-assessment models are designed around the concept that the entire area is open for exploration. The model identifies and tests all prospects to determine their commercial viability. To support this approach, the EIS clearly describes the inherent uncertainty in estimating undiscovered resources and the fraction of this unknown volume likely to be discovered and developed relative to perceived industry interest/effort. This uncertainty is magnified by the uncertainty associated with estimates of the environmental and socioeconomic effects resulting from the assumed exploration and development scenarios. The EIS also discusses the accuracy of resource estimates for the various alternatives or limited number of sales.

The EIS evaluates the biological effects as required under the Endangered Species Act, including all exploration activities in the Beaufort Sea Planning Area for Sales 186, 195, and 202. The draft EIS, which also gave our Biological Evaluation, was submitted to the National Marine Fisheries Service and the Fish and Wildlife Service to initiate formal consultation. The Fish and Wildlife Service prepared programmatic Biological Opinions for species under their jurisdiction for all OCS leasing and exploration activities to be conducted in the Beaufort Sea. The National Marine Fisheries Service issued a new Beaufort Sea Biological Opinion dated May 25, 2001, that included all OCS leasing and exploration activities in the Beaufort Sea OCS Planning Area. The MMS requested that the National Marine Fisheries Service uphold their May 2001 Biological Opinion concerning Beaufort Sea oil and gas leasing and exploration activities for proposed Lease Sales 186, 195, and 202. The MMS has determined that activities expected from the proposed Sales 186, 195, and 202 are similar to those considered in the May 25, 2001, Beaufort Sea Biological Opinion. The MMS also has determined that there is no new information regarding effects of these activities on bowhead whales nor are there any activities not previously considered in the Beaufort Sea Biological Opinion and the National Marine Fisheries Service agreed with our assessment.

The EIS also includes analysis of essential fish habitat and consultation that covers leasing and exploration activities for all three sales.

I.F.2. Processes for Subsequent Sales 195 and 202

After Sale 186 is held, if it is held, the MMS will decide whether to initiate the planning process for the next sale with an EA and, if warranted, a supplemental EIS. The MMS will review current issues and new information and, if that review results in no significant change from those addressed in the multiple-sale EIS, the MMS will prepare an EA and issue a FONSI. If that review results in new issues or sufficient new information not addressed in the multiple-sale EIS, the MMS will prepare a supplemental EIS. As soon as the decision is made, the MMS will announce its intention to prepare either an EA or a supplemental EIS through a press release, or mailout, and issue a *Federal Register* notice.

I.G. Streamlining Statement

Readers of this multiple-sale EIS, as with the previous Sale 170 EIS, are alerted to some differences in this EIS from previous Alaska OCS Region EIS's. While this EIS is more complicated because it addresses three sales, we have tried to streamline the EIS to provide a more concise, reader-friendly, and useful analysis of potential effects and impacts of proposed activities.

We are attempting to eliminate much of the repetition from previous EIS's. We analyze new, relevant information and incorporate background information by reference, when appropriate, providing only a concise summary for text continuity.

Such streamlining follows the intent of the Council on Environmental Quality regulations in 40 CFR § 1502.21, which encourage agencies to incorporate material by reference into an EIS to decrease volume without impeding agency analysis and public review of the action being considered. In this EIS, we cite the incorporated material and briefly describe its content. All material incorporated by reference is reasonably available for inspection by interested persons within the public comment period and is available in local libraries and from the MMS Alaska OCS Region office.

I.H. Important Differences between the Draft EIS and the Final EIS

The following summarizes some of the more important changes that have been made in the final EIS as a result of the public review of the draft EIS.

- The Alternatives (deferral options) stayed the same; no new additions or deletions were included, although the descriptive titles for Alternatives III, IV, and IV where changed from "Subsistence Whale" to "Subsistence Whaling."
- Alternative I is identified as the Agency-Preferred Alternative and is addressed in Section II.I.
- Stipulation No. 8 – Lighting of Lease Structures to Minimize Effects to Spectacled and Steller's Eider was added, as required by the Fish and Wildlife Service's Biological Opinion.
- Text revisions focused on major issues dealing with marine mammals, subsistence, the bowhead whale, and environmental justice. These sections incorporated new information as well as sources of traditional knowledge. Where comments warranted other changes or presentation of new or additional information, revisions were made to the appropriate text in the final EIS. If changes or additions were made to the text as a result of comments received, Section VII includes the comments received plus our response to that comment.

SECTION II

ALTERNATIVES INCLUDING THE PROPOSED ACTION

Contents for Section II

II. Alternatives, including the Proposed Action

This section discusses the sale approach and structure (Section II.A), the resource estimates, development scenarios, and a summary of effects for each of the three sales covered in this EIS for the proposed action, Alternative I (Section II.B), the No Lease Sale Alternative (Section II.C), and each of the deferral alternatives to the proposed action (Sections II.D through II.G). Section II.H discusses mitigating measures. These include the standard mitigating measures that are a part of the proposed action and alternatives and an evaluation of the effectiveness of additional stipulations that are considered in this EIS. Section II.I describes the Agency-Preferred Alternative(s).

II.A. Approach to Analysis and Oil and Gas Resource Potential

II.A.1. Approach to Analysis

This EIS encompasses the three proposed Beaufort Sea lease sales (Sales 186, 195, and 202) that are identifed in the 2002-2007 5-year program. The MMS has divided the Beaufort Sea Planning Area into three zones: Near/Shallow (Near Zone), Midrange/Medium (Midrange Zone), and Far/Deepwater (Far Zone) (see Map 4). We have done this for purposes of analysis because of the unique environmental characteristics of each zone and the logistics required for development. The zones are defined primarily by their proximity to existing North Slope infrastructure and secondarily by water depths. Water depths will influence the types of rigs and platforms used for exploration and development. Additional description of new infrastructure requirements is contained in Appendix B, and a discussion of potential developmental effects for each of the zones is given in Section IV.A. Effects are analyzed in Section IV.C for each of the three proposed sales and their six alternatives. Cumulative effects are analyzed in Section V.

Table II.A-1 indicates that most of the activities associated with the three sales are expected in the Near Zone, although leasing, exploration, and some development could take place anywhere in the large Beaufort Sea Planning Area. (When we use the term “expected” in this EIS, we are indicating what would be expected if the scenarios we constructed for evaluation purposes actually happen. Similar scenarios in past EIS’s generally have not been realized.) Nevertheless, past experience onshore and in State waters has shown that exploration and subsequent development will expand into more remote and higher cost areas after opportunities are largely exhausted in areas more readily accessible from existing infrastructure. A basic description of the physical characteristics, infrastructure development, and potential resource estimates for each of the zones follows.

II.A.1.a. Near/Shallow Zone

This zone is in the central Beaufort Sea in shallow water offshore Prudhoe Bay, where a considerable amount of infrastructure exists (see Map 4). Water depths typically are 10 meters or less, and distances from existing facilities are not more than a few tens of miles. This geographic zone extends from the Colville River on the west to the Canning River on the east. Expected development generally can be described as being relatively small fields producing at modest rates with short, small-diameter pipelines. Development platforms probably would be artificial gravel islands or mobile concrete structures set on the seafloor. Small fields could lower their development cost by using adjacent processing facilities, and small satellite oil pools could be tapped using extended-reach wells drilled from existing production islands. Overall, new oil fields developed in this zone represent a very minor addition to ongoing activities in this part of the Beaufort Sea. We expect that no new landfalls, shore bases, or new onshore processing facilities would be required.

II.A.1.b. Midrange/Medium Zone

This zone surrounds the Near Zone (see Map 4) and extends into deeper and more remote areas of the Beaufort OCS. It includes areas in water depths to approximately 30 meters and extends from Cape Halkett on the west to Barter Island on the east. New fields in this zone would be farther from existing oil and gas infrastructure, and the costs of developing new oil fields will be higher, which means that the oil pools would have to be somewhat larger then those in the Near Zone. Development could resemble the Near Zone in shallow-water areas, although more emphasis could be placed on extended-reach drilling and subsea wells to recover oil from areas farther offshore. Pipelines would be bigger and longer and would carry higher flow rates from these larger fields. Some large projects could involve more than one platform, and a new pipeline landfall could be required. Staging and logistical support still would be from the Prudhoe Bay area, and no new shore base would be necessary. Because this zone is at the fringe of existing development on the North Slope, new development projects could introduce changes to the level of activities experienced in this area.

II.A.1.c. Far/Deepwater Zone

This zone covers the remainder of the program area (see Map 4), extending from offshore Barrow on the west to the Canadian border on the east. All of the deepwater areas (deeper than 30 meters) in the Beaufort multiple-sale area would be included in this zone. New fields in this zone are much farther from existing North Slope infrastructure, and the costs to develop new oil fields would be substantially higher, which means that the commercial oil pools would have to be much larger than those in the other two zones. Small oil fields in the Far Zone might be discovered by exploration; however, these small fields likely would not be economic or developed in the near term. Development could resemble a combination of the other two zones, because remote areas contain shallow, medium, and deepwater. More emphasis could be placed on extended-reach drilling and subsea wells to recover oil from deepwater areas farther offshore. Pipelines would be larger and longer and would carry higher flow rates from these larger fields. A new large-diameter onshore pipeline could be required to connect to the existing feeder system to the Trans-Alaska Pipeline System. Most projects would involve several platforms (perhaps different types in different water depths) along with a new pipeline landfall. Staging and logistics support would be from a new shore base constructed in a favorable location to handle both overland and marine transportation subject to seasonal constraints. Because this zone is mostly beyond the influence of existing infrastructure on the North Slope, new development projects could introduce significant changes to the level of activities experienced in this area.

II.A.2. Oil and Gas Resource Potential

Crude oil is expected to be produced as a result of these three proposed lease sales, if commercial discoveries are found and developed. No gas resources in the Beaufort Sea are feasible to produce, because no gas-transportation system exists from the North Slope to outside markets. For purposes of analysis, we assume that 460 million barrels could be discovered and produced from each of the three sales. The 460 million barrels we assume to be discovered and developed in each sale would be 20% of the total multiple-sale area resources. These assumptions reflect the difficulty in finding new prospects, current technology, and industry effort.

Table II.A-2 indicates the number of blocks deferred by each alternative (II through VI) and the number of blocks that remain in the proposed sale area for each of the sales, should the deferral be selected. Table II.A-3 indicates the opportunity index (commercial chance) that commercial-sized resources may be contained in each deferral alternative. This opportunity index is shown as a percentage (probability) and represents the probability that commercial fields would be leased, drilled, discovered, and developed in a specific deferral area. No one can accurately define the location of future oil fields. Because commercial oil resources are not uniformly distributed, oil pools covered by only a few tracts could contain all of the economically recoverable reserves in the sale area. The remainder of the area could either lack the geology to produce large oil pools or have other conditions that would preclude commercial viability. It is important to note that this resource estimate reflects the current data and knowledge of the MMS. Individual companies could have a much different view of the oil potential in the Beaufort Sea OCS. Future leasing patterns may reflect different industry views regarding the possible location of commercial-sized fields in the program area.

The locations of future commercial offshore fields that presently are undiscovered are impossible to predict without exploration drilling. Petroleum-assessment models statistically analyze the geology and engineering characteristics of the area to determine the total resource volume that is expected to be economically viable to produce if discovered. While these total resource estimates are valid on a regional scale, they cannot be subdivided into smaller fractions and still be meaningful as real volumes of oil. However, a risk-weighting method can be used to define the chance that the resource volume will occur in a particular subarea.

We use the term "opportunity index" to describe that risk-weighted probability. To understand the index, suppose, for example, that an OCS area contained a total of 500 million barrels of economically recoverable oil in any of five prospects. Suppose, also, that each prospect is the same size and equally likely to contain recoverable oil. The risk-weighted volume assigned to each prospect would be 100 million barrels. The opportunity index assigned to each prospect would be 20%. This means that there is a 20% chance (or one-in-five chance) that 500 million barrels could be discovered in any single prospect, but the others would be dry. If a deferral option removed two of the five prospects, we would not subtract 200 million barrels from the total but would lose 40% of the opportunity to discover the 500 million barrels.

The opportunity index is defined by outputs from geologic and economic assessment models based on currently available data. These models assume that leasing, exploration, and development are unrestricted by regulations or industry funding. In reality, access to untested tracts and exploration budgets are key determinants of the level of industry interest in an area. Oil prices and government regulations also are key determinants. Low oil prices and overly restrictive regulations could lessen industry interest in an area despite its high geologic potential. Future oil prices are difficult to foresee, and future corporate strategies for leasing are impossible to accurately predict. We can base our analysis of resource potential only on past leasing trends and petroleum assessments using current data. Each company may have a very different perspective of the development potential of a frontier area such as the Beaufort Sea. The key concept is that industry will only bid on tracts that they believe have some chance of becoming viable oil fields.

Notwithstanding the value of the opportunity index in understanding how to think about the likelihood of finding oil and gas resources, we caution the reader to exercise care in drawing conclusions about the opportunity index. The reader needs to keep in mind the full context of the preceding paragraphs when considering the opportunity index figures cited for Alternatives III through VI in Sections D through G that follow.

II.B. Alternative I - the Proposal for Sales 186, 195, and 202

In this section, we describe (a) the three-sale/three-zone structure, (b) resource estimates and development scenarios, and (c) timing of activities. For additional information on resources and development activities, see Appendix B and Section IV.A.1 of this document. Section II.B.3 and Tables II.A-4, II.A-5, and II.A-6 provide a summary of effects by resource category for each of the sales.

Alternative I, the Proposal for Sales 186, 195, and 202, offers for lease the entire area outlined on Map 1. This Alternative encompasses 1,877 whole or partial blocks that cover 9,770,000 acres (about 3,954,000 hectares). This area, minus leased blocks, would be offered in each of the three sales. For each of the proposed sales, the MMS assumes three different exploration and development scenarios. The level of activities and types of exploration and development components are further grouped into three geographic zones (see Map 4) based primarily on distance to existing infrastructure and secondarily by water depth.

Resource estimates for each of the proposed sales vary between 340 million and 570 million barrels of oil, assuming a market price of oil between $18 and $30 per barrel (in 2000$). For purposes of analysis, we use a single production volume of 460 million barrels of oil for each sale.

II.B.1. Sale 186

The basic assumption is that as the lease-sale program progresses, activities would expand into more distant zones. The most accessible and easiest tracts are expected to be developed first. For purposes of analysis, we expect that 70% of all blocks leased for this sale would be in the Near Zone, 20% in the Midrange Zone, and only 10% in the Far Zone (see Table II.A-1).

II.B.1.a. Sale 186 Exploration Activities

We assume that exploration activity (seismic surveys and drilling) begins in the year following Sale 186 (scheduled for 2003) and continues at a rate of one exploration well per year for a total of six exploration wells. We assume three commercial discoveries (two discoveries in the Near Zone and one in the Midrange Zone, a 50% success rate), which is very optimistic. Following the next discovery, we assume delineation wells would employ the same drilling rig and continue over a 2-year period. Two delineation wells may be drilled in a single season as rig mobilization has already happened. Artificial ice islands grounded on the seabed are likely to be used as drilling platforms in shallow water (less than 10 meters), and nearshore operations would be supported by ice roads over the landfast ice. Gravel islands are not likely to be constructed to drill exploration wells in OCS waters (generally deeper than 10 meters), although older artificial islands or natural shoals could be used as a base for temporary gravel or ice islands. Bottom-founded platforms (set on the seafloor) could be used to drill prospects in water depths of 10-20 meters, and drillships would be used to drill prospects in water deeper than 20 meters. Because mobile ice conditions in deeper water makes ice roads unfeasible, deeper water (Far Zone) operations would take place during the summer open-water season and would be supported by icebreakers and supply boats.

II.B.1.b. Sale 186 Development Activities

In our development schedule (Table IV.A-1), we assume that the first commercial discovery would be made in 2005, 2 years after Sale 186 is held. We assume that three new fields ranging in size from 120-220 million barrels of oil would be discovered in alternate years. Assuming no delays in permitting, production platforms could be installed in 4 years following the discovery well. The MMS assumes that the fields discovered and developed would be this size and could be produced by one production platform, perhaps as a satellite with minimal onsite processing facilities. Each platform would contain one rig for development-well drilling and well-workover operations. Gravel islands would be the favored design for production facilities in water depths approximately 15 meters or less, and bottom-founded platforms would be employed for production facilities in water depths to 35 meters. Some oil may be produced by wells using extended-reach drilling technology, which would enable the operators to reach oil pools located in strata that lie beneath deeper OCS waters. However, the volume of oil developed by extended-reach drilling likely would represent a minor proportion of the total production from the three new fields.

The route selection and installation of offshore pipelines would take 1-2 years, and could occur either in the summer open-water season, during mid- to late winter when landfast ice has stabilized, or both. New onshore pipeline sections would take 1 year to complete with construction activities taking place simultaneously with installation of the offshore pipeline. We assume that offshore pipelines would be trenched as a protective measure against damage by ice in all water depths less than 50 meters (164 feet). Onshore pipelines would be elevated 5 feet above ground level on vertical support members. The onshore pipeline corridor, and shore-facility construction would be concurrent with the offshore platforms installation.

Because of their relatively small size, new offshore projects would use the existing infrastructure (processing facilities and pipeline-gathering systems) wherever possible. Produced oil would be gathered by existing pipeline systems within the Prudhoe Bay/Kuparuk field areas and transported to Pump Station 1 of the Trans-Alaska Pipeline. We assume that Oliktok Point (using the Kuparuk or Milne Point field infrastructure), the Northstar pipeline landfall, West Dock (using the Prudhoe Bay field infrastructure), and the Badami field would be the primary landfalls.

Production rates would quickly ramp up to peak production rates for 3 years before declining. A typical field cycle from discovery to abandonment lasts 21 years, or approximately 5 years from discovery to startup, a 15-year production life, and 1-year abandonment phase. Considering the staggered discovery times of the fields, activities resulting from Sale 186 could last until the year 2033 (Table IV.A-1 and Appendix B).

II.B.2. Sale 195

We expect that as each lease sale proceeds, blocks would be leased in increasingly distant zones. The most accessible and easiest tracts should be developed first. We assume that many of those blocks would be leased and explored for Sale 186. For Sale 195, we expect activities to extend farther into the Beaufort Sea, into the Midrange Zone. We expect the percentage of all blocks leased for this sale in the Near Zone should fall to 50%, the percentage of blocks leased in the Midrange Zone should rise to 30%, and the remaining 20% of the blocks would be leased in the Far Zone (see Table II.A-1).

Sale 195 Exploration and Development Activities. Sale 195 exploration and development activities and timeframes likely would vary only slightly from Sale 186. Total exploration and development wells drilled would be the same (Table IV.A-2), and the type of exploration and production platforms used would be the same. Exploration drilling would begin in 2005, 2 years after the sale is held. A commercial discovery would be assumed 3 years after the sale, with production platforms installed beginning in 2012. We assume two new fields (as opposed to three for Sale186) would be discovered, with production potential for each field ranging from 120-340 million barrels of oil. The first production platform would be online in 2012 with production beginning 1 year later. Production from Sale 195 tracts is expected to continue until 2036, 3 years beyond the end of Sale 185 production. Assumed pipeline landfall sites for this sale would be the same as assumed for Sale 186; however, because of the assumed potential for Sale 195 to develop resources in blocks farther from existing infrastructure, a new support facility is forecast to be constructed near Point Thomson. The Exxon Corporation is proposing the development of the Point Thomson field, which includes offshore lease tracts in State waters. If the field is developed, a support facility would be constructed at Point Thomson independent of any activities related to Sale 195.

II.B.3. Sale 202

We expect that as each lease sale proceeds, blocks would be leased in increasingly distant zones. For Sale 202, we hypothesize that activities would extend even farther into the Beaufort Sea; into the Midrange and Far zones. We estimate the percentage of all blocks leased for this sale in the Near Zone should fall to 40%, the percentage of blocks leased in the Midrange Zone would stay at 30%, and the percentage of blocks leased in the Far Zone would rise to 30% (see Table II.A-1).

Sale 202 Exploration and Development Activities. Exploration and development timeframes and activities might vary somewhat from those considered for Sales 186 and 195 (see Table IV.A-3). Exploration activities would be expected to begin 3 years after the sale date, with an estimated total of 11 exploration and delineation wells drilled over an 8-year period. Exploration platform types used for Sale 202 also likely would be the same as those described previously for Sale 195. However, for the production phase, deeper and/or more distant production operations, should they occur, may require bottom-founded ice-reinforced steel or concrete structures. For Sale 202, we assume that a single field would produce 460 million barrels of oil over its life from two platforms, a main and a satellite platform. Some production may come from extended-reach drilling and/or subsea completions to reach oil pools that may lie under deeper waters. For Sale 202, the first production platform is estimated to be completed in 2018, with production beginning the next year. Oil production could continue until 2038. We assume that there could be 35 miles of offshore pipeline for this alternative, which is 5 miles shorter than for Sales 186 and 195. However, Sale 202 assumes a new landfall distant from existing oil infrastructure and, therefore, its development may require a new overland pipeline. Candidate sites for a new pipeline landfall could be Point Thompson and Smith Bay, among others. Please see Table IV.A-4, Section IV.A.1, and Appendix B for a further comparison of these sales.

II.B.4. Summary of Effects by Sale

In this section, we summarize the effects by category of holding the three sales, should the Secretary decide to hold Sale 186 in 2003 (Table II.A-4), Sale 195 in 2005 (Table II.A-5), and Sale 202 in 2007 (Table II.A-6). For purposes of analysis, the MMS assumes that 460 million barrels of oil could be discovered and produced for each sale, based on an estimated range of 340-570 million barrels per sale. Only a small percentage of the blocks available for lease under the proposed action for Sales 186, 195, and 202 likely would actually be leased. Of the blocks that may be leased, only a portion would be drilled and of these, only a very small portion, if any, likely would result in production. At this time, gas is not considered economically recoverable.

If any of the lease sales are held and result in exploration and/or development, routine industrial activities associated with oil exploration and development would generate some degree of disturbance, noise, and discharges into the environment. The EIS found that no significant effects are anticipated from routine permitted activities. Significance thresholds are defined in Section IV.A.1. Although small oil spills are accidental in nature, they are expected to happen should exploration, development, and production occur; therefore, we include the effects of small spills to the environment in this part of the analysis.

Other accidents or unplanned activities, primarily large oil spills equal to or greater than 1,000 barrels of oil, are not expected to occur. The probability of a large spill equal to or greater than 1,000 barrels for each of the three sales is 8-10% (see Table A.1-5). For analytical purposes, the analysis assumes one large spill of either 1,500 barrels (platform spill) or 4,600 barrels (pipeline spill). The low probability of such an event, combined with the seasonal nature of the resources inhabiting the area, make it highly unlikely that a large oil spill would occur and contact these resources. Spectacled eiders, long-tailed ducks, and common eiders are present on the North Slope for only 3-5 months out of the year. Bowhead whales migrate through the area in the spring and fall, and the length of time a whale could contact oil would likely be limited to days or weeks. Even if a resource is present in the area, the oil may not contact it. In the unlikely event of such a large oil spill, significant adverse effects could occur to local water quality; common, spectacled, and Steller's eiders; long-tailed ducks; subsistence harvests; and sociocultural systems.

The effects summarized by resources for Sale 186 are presented in Table II.A-4, Sale 195 in Table II.A-5, and Sale 202 in Table II.A-6. The summaries of significant effects noted above apply to each individual sale and for all of the deferral alternatives for each sale. The deferral alternatives (Alternatives III through VI) provide various degrees of protection to the resources in or near those specific areas for each sale; however, none of the deferral alternatives changes the level of significant impacts identified above for any of the proposed sales. This is primarily because all of the alternatives for all of the sales assume the same amount of oil (460 million barrels) would be developed, even though the opportunity to find that volume of oil changes with the selection of one or more alternatives. The economics of developing an oil field in the Beaufort Sea requires that certain minimum quantities of oil be discovered, otherwise, development will not occur. While the economic quantities required for development vary between the Near, Midrange, and Far zones, the amount of oil MMS assumes in the EIS for the alternatives in each of the three sales does not vary. In addition, many of the key resources migrate in and out of the Beaufort Sea area, and many of the key species use large areas of the Beaufort Sea area when they are present.

The scenarios that MMS developed for Sales 186 and 195 are very similar, with leasing and exploration, development, and operations occurring from both sales in the Near and Midrange zones. Therefore, the effects to each of the resources from both of these sales are very similar. The MMS scenarios for Sales 186 and 195 expect most of the activities to occur in the central Beaufort Sea; therefore, Alternatives III, V, and VI, which are outside the central area, do not provide identifiable benefits or differences. For Sale 202, the scenarios developed by MMS, assume activities would occur outside of the central Beaufort Sea area, and the EIS identifies different levels of effects between the deferral alternatives, although none of the alternatives change the overall level of significance effects.

In addition to Tables II.A-4, II.A-5, and II.A-6, Table IV-Summary provides a summary by resource category for all alternatives and sales.

II.C. Alternative II - No Lease Sale

Under this Alternative, each of the proposed sales in the Beaufort Sea multiple-sale program would not be approved. None of the potential 0.46 billion barrels of oil would be produced for each sale, and none of the environmental effects that would result from proposed oil development associated with each sale would occur in the Beaufort Sea area. No potential oil spills and no effects to the physical, biological, or human environment from development from this sale would occur along the Beaufort Sea coast. The economic benefits, royalties, and taxes to the Federal and State Governments would be forgone. A similar decision could be made for each sale.

To replace the .046 billion barrels of oil not developed from each sale in the Beaufort Sea multiple-sale program, a large portion of the oil likely would be imported from other countries. Other substitutes (for example, nonpetroleum fuels, solar energy, nuclear energy, conservation) could replace a small part of the lost production. The mix of imported oil and other substitutes will be market driven. See Section IV.B of this EIS, and Sections 2.5 and 4.7 (Pages 2-36 to 2-37 and 4-187 to 4-202) of the OCS Oil and Gas Leasing Program: 2002-2007 Final EIS (USDOI, MMS, 2002a), which is incorporated by reference. That analysis shows that nationwide, imports would replace 86-88% of the lost oil. Conservation would replace about 6-7%, and increased use of natural gas would replace about 4-5% of the lost oil production. Increased onshore oil production is estimated to offset about 3% of lost offshore production. However, even if Alternative II were selected, the Beaufort Sea still would be exposed to other ongoing oil and gas and other activities in the area.

Because of the projected high level of imports, the associated environmental impacts from producing oil and transporting that oil to market still would occur, but in a different location, and they probably would be of a different magnitude. Imported oil imposes negative environmental effects in producing countries and in countries along the trade routes. By not producing our own domestic oil and gas resources in the Beaufort Sea and elsewhere around the U.S., we are relying on imported oil. From a global perspective, by importing oil we are exporting at least a sizeable portion of the environmental impacts associated with oil we consume to other countries where the oil is produced and to those countries along the tanker routes. Also, these imports have attendant negative effects on the Nation's balance of trade (see Section IV.C).

II.D. Alternative III - Barrow Subsistence Whaling Deferral

This alternative was developed by the MMS in response to scoping comments received in Barrow. This deferral would reduce potential conflicts between bowhead whale subsistence hunters and offshore oil and gas operations, based on bowhead whale-strike data provided by the Alaska Eskimo Whaling Commission. This alternative would offer for leasing all of the area described for Alternative I except for a subarea located in the western portion of the proposed sale area. Alternative III would offer 1,851 whole or partial blocks, comprising 9.6 million acres (about 3.9 million hectares). The area that would be removed by the Barrow Subsistence Whaling Deferral (see Map 2) consists of 26 whole or partial blocks, approximately 138,000 acres (55,735 hectares), approximately 1% of the proposed sale area. This alternative also would result in a reduction of 1% of the commercial resources opportunity index from the proposed action (see Table II.A-3). This option is analyzed for protection of subsistence-use zones and wildlife areas, particularly comprising an area in which whales have been taken (based on known whale-strike data), to address issues of protecting areas of the Barrow subsistence whale hunt. Section IV.C of this EIS analyzes whether increased protection would be provided by this alternative to bowhead whales and subsistence activities from potential noise and disturbance from exploration or development and production activities. See Tables II.A-4, II.A-5, II.A-6, and IV.A-Summary. The majority of the bowhead whale subsistence-hunting area near Barrow includes area in the Chukchi Sea, which already was removed from leasing in the final 2002-2007 proposed 5-year program. While the selection of this alternative decreases the opportunity of discovering a commercial field, the resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area.

II.E. Alternative IV - Nuiqsut Subsistence Whaling Deferral

This alternative would offer for leasing all of the area described for Alternative I except for a subarea located off Cross Island. Alternative IV would offer 1,847 whole or partial blocks, comprising 9.6 million acres (about 3.9 million hectares). The area that would be removed by the Nuiqsut Subsistence Whaling Deferral (see Map 2) consists of 30 whole or partial blocks, approximately 0.2 million acres (66 thousand hectares), about 2% of the Alternative I area. This alternative would result in a reduction of 5% of the opportunity of discovering and developing an economic field from a lease sale under Alternative I (see Table II.A-3). Section IV.C of this EIS analyzes whether this alternative would provides protection of subsistence-use zones and wildlife areas, particularly comprising an area in which whales have been taken (based on known whale-strike data). This alternative addresses issues of protecting areas of the Nuiqsut subsistence bowhead whale hunt as identified by the Alaska Eskimo Whaling Commission, the Native Village of Nuiqsut, and the North Slope Borough. See Tables II.A-4, II.A-5, II.A-6, and IV.A-Summary. Although the selection of this alternative decreases the opportunity of discovering a commercial field, the resources in this area still could be affected by a large oil spill that occurred from development offshore elsewhere in the Beaufort Sea.

II.F. Alternative V - Kaktovik Subsistence Whaling Deferral

This alternative would offer for leasing all of the area described for Alternative I except for a subarea located off of Barter Island. Alternative V would offer 1,849 whole or partial blocks comprising 9.6 million acres (about 3.9 million hectares). The area that would be removed by the Kaktovik Subsistence Whaling Deferral (see Map 2) consists of 28 whole or partial blocks, approximately 0.1 million acres (50 thousand hectares), about 1% of the Alternative I area. This alternative would result in a reduction of 3% of the opportunity of discovering and developing an economic oil field from a lease sale under Alternative I (see Table II.A-3). This area would be considered for deferral because of the potential disturbance to

Kaktovik's traditional, known subsistence-whaling areas (based on known whale-strike data). An analysis is conducted in Section IV.C to determine if this alternative provides protection of traditionally used bowhead whale subsistence areas, as requested by the Native Village of Kaktovik. See Tables II.A-4, II.A-5, II.A-6, and IV.A-Summary. While the selection of this alternative decreases the opportunity of discovering a commercial field, the resources in this area still could be affected by a large oil spill that occurred elsewhere in the Beaufort Sea area.

II.G. Alternative VI - Eastern Deferral

This alternative would offer for leasing all of the area described for Alternative I except for a subarea located east of Kaktovik. Alternative VI would offer 1,817 whole or partial blocks, comprising 9.5 million acres (about 3.8 million hectares). The area removed by the Eastern Deferral (see Map 2) consists of 60 whole or partial blocks, approximately 0.3 million acres (114 thousand hectares), about 3% of the Alternative I area. This deferral would result in a reduction of 3% of the opportunity of discovering and developing an economic oil field from a lease sale under Alternative I (see Table II.A-3). An analysis is conducted in Section IV.C of the level of protection of areas provided by this alternative, as requested by the Native Village of Kaktovik and the Alaska Eskimo Whaling Commission, and it adjoins an area that the State of Alaska has deferred in recent State sales. See Tables II.A-4, II.A-5, II.A-6, and IV.A-Summary. Although the selection of this alternative decreases the opportunity of discovering a commercial field, the resources in this area still could be affected by a large oil spill that occurred elsewhere in the Beaufort Sea area.

The MMS recently completed a bowhead whale-feeding study to assess the importance of the area to bowhead whales for feeding.

II.H. Mitigating Measures

Laws and regulations that provide mitigation are considered part of the Proposal (Alternative I) and Alternatives III through VI for Sales 186, 195, and 202. Examples include the OCS Lands Act, which grants broad authority to the Secretary of the Interior to control lease operations and, where appropriate, undertake environmental monitoring studies; the Consolidated Offshore Operating Regulations (which rescinded and replaced Alaska OCS Orders effective May 31, 1988); and the Fishermen's Contingency Fund.

Most of the following mitigating measures (Stipulations and ITL clauses) also are considered standard mitigating measures, because they have been selected in past OCS lease sales. Standard stipulations (Section II.H.1) and ITL clauses (Section II.H.3) are evaluated and factored into the effects analysis as part of the proposed action and alternatives. The environmental effects analyses in Section IV.C discuss the effectiveness of the stipulations described in this section where appropriate to a given resource. A summary of the overall effectiveness of each stipulation is provided in the following section, immediately after the text of the stipulation. Other mitigating measures were developed and analyzed in this EIS; these are found under Section II.H.2 for stipulations being developed. The optional stipulations are as follows: (a) Stipulation 6a No Siting of Permanent Facilities in the Vicinity of Cross Island for blocks outside the Barrier Islands, (b) Stipulation 6b No Siting of Permanent Facilities in the Vicinity of Cross Island for blocks inside the Barrier Islands, and (c) Stipulation 7 Pre-Booming Requirements for Fuel Transfers.

Some of the stipulations included in this analysis as assumed mitigating measures from past OCS oil and gas lease sales in the Beaufort Sea have been slightly reworded to bring them up-to-date with current information and situations (i.e., Protection of Biological Resources). Other changes were simply editorial (Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence Activities).

The ITL clauses included as assumed mitigating measures also have been somewhat revised from past sales. Some have not been included, because they have been incorporated into the MMS operating regulations (i.e., Oil-Spill-Response Preparedness, Oil-Spill-Cleanup Capability, and Certification of Oil-

Spill-Financial Responsibility) or are no longer applicable (Arctic Biological Task Force). Some have been updated with current information (Bird and Marine Mammal Protection, Coastal Zone Management).

II.H.1. Standard Stipulations

The following standard stipulations are considered part of the proposed action and alternatives.

- No. 1 - Protection of Biological Resources
- No. 2 - Orientation Program
- No. 3 - Transportation of Hydrocarbons
- No. 4 - Industry Site-Specific Bowhead Whale-Monitoring Program
- No. 5 - Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence Activities

A summary of the effectiveness of each stipulation follows the language of the stipulation

II.H.1.a. Stipulation No. 1 - Protection of Biological Resources

If 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 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 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 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, primary unknown kelp communities, or 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 (including the migration of fish) from potential disturbance associated with oil and gas exploration, development, and production. This stipulation does not change the level of significant impacts that may occur from an unlikely large oil spill.

II.H.1.b. Stipulation No. 2 - Orientation Program

The lessee shall include in any exploration or development and production plans submitted under 30 CFR 250.203 and 250.204 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, commercial fishing 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 any of the three sales 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. However, 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 or lower the level of significant impacts that may occur from an unlikely large oil spill.

II.H.1.c. Stipulation No. 3 - Transportation of Hydrocarbons

Pipelines will be required: (a) if pipeline rights-of-way can be determined and obtained; (b) if laying such pipelines is technologically feasible and environmentally preferable; and (c) if, in the opinion of the lessor, pipelines can be laid without net social loss, taking into account any incremental costs of pipelines over alternative methods of transportation and any incremental benefits in the form of increased environmental protection or reduced multiple-use conflicts. The lessor specifically reserves the right to require that any pipeline used for transporting production to shore be placed in certain designated management areas. In selecting the means of transportation, consideration will be given to recommendations of any advisory groups and Federal, State, and local governments and industry.

Following the development of sufficient pipeline capacity, no crude oil production will be transported by surface vessel from offshore production sites, except in the case of an emergency. Determinations as to emergency conditions and appropriate responses to these conditions will be made by the Regional Supervisor, Field Operations.

Summary of the Effectiveness of Stipulation No. 3. This stipulation reflects the agency preference for transporting offshore oil and gas in pipelines, especially in the arctic environment, where much of the area is covered by sea ice for much of the year. This stipulation is consistent with the North Slope Borough Coastal Management Program policy. This stipulation helps reduce or moderate the potential effects to water quality, lower trophic-level organisms, fish and fish migration, endangered species, marine mammals, etc.; however, it does not reduce the potential significant adverse effects from an unlikely large oil spill to any of potentially affected resource to below significance threshold levels.

II.H.1.d. Stipulation No. 4 - 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 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 the North Slope Borough (NSB) and the Alaska Eskimo Whaling Commission (AEWC), determine that a monitoring program is not necessary. The RS/FO will provide the NSB, AEWC, and the State of Alaska 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 whales are present in the vicinity of lease operations and the extent of behavioral effects on bowhead whales due to these operations. In designing the program, lessees must consider the potential scope and extent of effects that the type of operation could have on bowhead whales. 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:

(1) Recording and reporting information on sighting of other marine mammals and the extent of behavioral effects due to operations,
(2) Inviting an AEWC or NSB representative to participate in the monitoring program as an observer,
(3) Coordinating the monitoring logistics beforehand with the MMS Bowhead Whale Aerial Survey Project (BWASP),
(4) Submitting daily monitoring results to the MMS BWASP,
(5) 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 AEWC, the NSB, the State of Alaska, and the National Marine Fisheries Service (NMFS).
(6) 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 AEWC, the NSB, the State of Alaska, and the NMFS.

Lessees 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. 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 NSB, the AEWC, industry, NMFS, and MMS. 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 NSB, AEWC, and the State of Alaska.

In the event the lessee is seeking a Letter of Authorization (LOA) or Incidental Harassment Authorization (IHA) for incidental take from the NMFS, the monitoring program and review process required under the LOA or IHA may satisfy the requirements of this stipulation. Lessees 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 advise the lessee if the LOA or IHA will meet these requirements.

This stipulation applies to the following blocks for the time periods listed and will remain in effect until termination or modification by the Department of the Interior, after consultation with the NMFS and the NSB.

Spring Migration Area: April 1 through June 15

OPD: NR 05-01, Dease Inlet. Blocks included: 6102-6111, 6152-6167, 6202-6220, 6252-6270, 6302-6321, 6354-6371, 6404-6423, 6454-6473, 6504-6523, 6554-6573, 6604-6623, 6654-6673, 6717-6723

OPD: NR 05-02, Harrison Bay North: Blocks included: 6401-6404, 6451-6454, 6501-6506, 6551-6556, 6601-6609, 6651-6659, 6701-6716

Central Fall Migration Area: **September 1 through October 31**

OPD: NR 05-01, Dease Inlet. Blocks included: 6102-6111, 6152-6167, 6202-6220, 6252-6270, 6302-6321, 6354-6371, 6404-6423, 6454-6473, 6504-6523, 6554-6573, 6604-6623, 6654-6673, 6704-6723, 6754-6773, 6804-6823, 6856-6873, 6908-6923, 6960-6973, 7011-7023, 7062-7073, 7112-7123

OPD: NR 05-02, Harrison Bay North. Blocks included: 6401-6404, 6451-6454, 6501-6506, 6551-6556, 6601-6609, 6651-6659, 6701-6716, 6751-6766, 6801-6818, 6851-6868, 6901-6923, 6951-6973, 7001-7023, 7051-7073, 7101-7123

OPD: NR 05-03, Teshekpuk. Blocks included: 6015-6024, 6067-6072

OPD: NR 05-04, Harrison Bay. Blocks included: 6001-6023, 6052-6073, 6105-6123, 6157-6173, 6208-6223, 6258-6274, 6309-6324, 6360-6374, 6410-6424, 6461-6471, 6513-6519, 6565-6566

OPD: NR 06-01, Beechey Point North. Blocks included: 6901-6911, 6951-6962, 7001-7012, 7051-7062, 7101-7113

OPD: NR 06-03, Beechey Point. Blocks included: 6002-6014, 6052-6064, 6102-6114, 6152-6169, 6202-6220, 6251-6274, 6301-6324, 6351-6374, 6401-6424, 6456-6474, 6509-6524, 6868-6574, 6618-6624, 6671-6674, 6722-6724, 6773

OPD: NR 06-04, Flaxman Island. Blocks included: 6301-6303, 6351-6359, 6401-6409, 6451-6459, 6501-6509, 6551-6559, 6601-6609, 6651-6659, 6701-6709, 6751-6759, 6802-6809, 6856-6859,

Eastern Fall Migration: August 1 through October 31

OPD: NR 06-04, Flaxman Island. Blocks included: 6360-6364, 6410-6424, 6460-6474, 6510-6524, 6560-6574, 6610-6624, 6660-6674, 6710-6724, 6760-6774, 6810-6824, 6860-6874, 6910-6924, 6961-6974, 7013-7022, 7066-7070, 7118-7119

OPD: NR 07-03, Barter Island. Blocks included: 6401-6405, 6451-6455, 6501-6505, 6551-6555, 6601-6605, 6651-6655, 6701-6705, 6751-6756, 6801-6807, 6851-6859, 6901-6911, 6958-6963, 7010-7013, 7061-7067, 7113-7117

OPD: NR 07-05, Demarcation Point. Blocks included: 6016-6022, 6067-6072, 6118-6125, 6169-6175, 6221-6226, 6273-6276, 6323-6326

OPD: NR 07-06, Mackenzie Canyon. Blocks included: 6201, 6251, 6301, 6351

Summary of the Effectiveness of Stipulation No. 4. This stipulation provides site-specific information about the migration of bowhead whales that could occur from oil and gas activities from the proposed lease sales. The information can be used to evaluate the threat of harm to the species and provides immediate information about the activities of bowhead whales and their response to specific events. This stipulation helps address the National Marine Fisheries Service 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.

II.H.1.e. Stipulation No. 5 - 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).

Prior to submitting an exploration plan or development and production plan (including associated oil-spill contingency plans) to the MMS for activities proposed during the bowhead whale migration period, the lessee shall consult with the directly affected subsistence communities, Barrow, Kaktovik, or Nuiqsut, the North Slope Borough (NSB), and the Alaska Eskimo Whaling Commission (AEWC) to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures which could be implemented by the operator to prevent unreasonable conflicts. Through this consultation, the lessee shall make every reasonable effort, including such mechanisms as a conflict avoidance agreement, 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.

A discussion of resolutions reached during this consultation process and plans for continued consultation shall be included in the exploration plan or the development and production plan. In particular, the lessee shall show in the plan how its activities, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities. Lessees shall also include a discussion of multiple or simultaneous operations, such as ice management and seismic activities, that can be expected to occur during operations in order to more accurately assess the potential for any cumulative affects. Communities, individuals, and other entities who were involved in the consultation shall be identified in the plan. The Regional Supervisor/Field Operations (RS/FO) shall send a copy of the exploration plan or development and production plan (including associated oil-spill contingency plans) to the directly affected communities, and the AEWC at the time they are submitted to the MMS to allow concurrent review and comment as part of the plan approval process.

In the event no agreement is reached between the parties, the lessee, the AEWC, the NSB, the National Marine Fisheries Service (NMFS), or any of the subsistence communities that could be affected directly by the proposed activity may request that the RS/FO assemble a group consisting of representatives from the subsistence communities, AEWC, NSB, NMFS, and the lessee(s) to specifically address the conflict and attempt to resolve the issues before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests. Upon request, the RS/FO will assemble this group if the RS/FO determines such a meeting is warranted and relevant before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests.

The lessee shall notify the RS/FO of all concerns expressed by subsistence hunters during operations and of steps taken to address such concerns. 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.

Summary of the Effectiveness of Stipulation No. 5. This stipulation, which has evolved from the Oil/Whaler Cooperative Program required in Sale 97, has been adopted in all Beaufort Sea sales since Sale 124, although the wording and requirements of the stipulation have changed over time. This stipulation helps reduce potential conflicts between subsistence hunters and whalers and potential oil and gas activities. This stipulation helps to reduce noise and disturbance conflicts from oil and gas operations during specific periods, such as the annual spring and fall whale hunts. It requires that the lessees meet with local communities and subsistence groups to resolve potential conflicts. This stipulation reduces the potential adverse effects from the proposed sales to subsistence-harvest patterns, sociocultural systems, and to environmental justice. This stipulation was requested during scoping by the North Slope Borough and the Alaska Eskimo Whaling Commission. The consultations required by this stipulation ensure that lessees, including contractors, consult and coordinate both the timing and siting of events with subsistence activities.

This stipulation has proven to be effective in mitigating prelease (primarily seismic activities) and exploration activities through the development of the annual oil/whaler agreement between the Alaska Eskimo Whaling Commission and oil companies. The requirements of the stipulation apply to development and production activities and can reduce the potential adverse effects to subsistence-whaling activities.

This stipulation provides mitigation to same subsistence-whaling activities as those being addressed in potential Stipulations 6a and 6b. Stipulation 5 is more general and applies all oil and gas activities and to the whole sale area, if adopted. Stipulations 6a and 6b address only a very specific area around Cross Island for development and production. Stipulation 6a prohibits the siting of permanent facilities outside the barrier islands, unless the lessee demonstrates to the Regional Supervisor/Field Operations, in consultation with Alaska Eskimo Whaling Commission and the North Slope Borough, that the proposed facility will not preclude reasonable subsistence access to whales. The consultation and negotiation process for the lessee could be very similar to the process used for Stipulation 5.

Because of the consultative nature of this stipulation, we cannot determine the differences in protection offered to subsistence-whaling activities, specifically in the Cross Island area, between Stipulations 5 and 6a. Stipulation 6b, which limits the siting of permanent facilities inside the barrier islands would provide little if any additional protection to that offered by Stipulation 5, because subsistence whales and the whale migration occur seaward of the barrier islands.

II.H.2. Other Stipulations Developed for Consideration in this EIS

II.H.2.a. Stipulation No. 6a - Permanent Facility Siting in the Vicinity Seaward of Cross Island

Permanent OCS production facility siting within a defined 10-mile radius seaward of Cross Island will be prohibited unless the lessee demonstrates to the satisfaction of the Regional Director, in consultation with the North Slope Borough and the Alaska Eskimo Whaling Commission, that the development will not preclude reasonable subsistence access to whales. In making such a demonstration, the lessee shall follow the processes and requirements for consultation and mitigation of unreasonable conflicts as set out in Stipulation No. 5.

For purposes of analysis and for decision making, this stipulation is divided into two parts. Stipulation 6a will apply the 10-mile radius around Cross Island only outside the barrier islands. Stipulation 6b will apply the 10-mile radius only to those blocks within the barrier islands. The EIS analysts will conduct their evaluation of the effects of the proposed action and its Alternatives taking into account these two subsets of Stipulation 6 and will discuss any difference in effects that these stipulations may cause.

> **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 of Stipulation No. 6a. This stipulation prohibits permanent facilities within the 10-mile radius seaward of the barrier islands, unless the lessee demonstrates to the satisfaction of the MMS Regional Director, in consultation with the North Slope Borough and the Alaska Eskimo Whaling Commission, that the development will not preclude reasonable subsistence access. This stipulation would reduce the potential conflict between subsistence-hunting activities and oil and gas development and operational activities with the key areas seaward of Cross Island where the community of Nuiqsut's subsistence whaling takes place. This stipulation also could reduce that potential that noise from a facility in this area could deflect the bowhead whales farther offshore.

As stated above, Stipulation 5 and potential Stipulations 6a and 6b are directed towards mitigating potential subsistence conflicts. To a great extent, these stipulations are duplicative. They both require the lessee to meet and consult with the subsistence hunters. They both require negotiation and agreement before activities could proceed. Stipulation 5 covers exploration activities in addition to development and production activities over the entire sale area. Stipulations 6a and 6b cover permanent facilities only within a 10-mile radius seaward of Cross Island.

Stipulation 6a 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.

II.H.2.b. Stipulation No. 6b - Permanent Facility Siting in the Vicinity Shoreward of Cross Island

Permanent OCS production facility siting within a defined 10-mile radius shoreward of Cross Island will be prohibited unless the lessee demonstrates to the satisfaction of the Regional Director, in consultation with the North Slope Borough and the Alaska Eskimo Whaling Commission, that the development will not preclude reasonable subsistence access to whales. In making such a demonstration, the lessee shall follow the processes and requirements for consultation and mitigation of unreasonable conflicts as set out in Stipulation 5.

> **OPD; NR 06-03 Beechey Point; Blocks:** 6616B, H, I; 6664C, H, I; 6665C, G, H, I, K; 6666D, G, H, J; 6667C, D, G; 6668B, C, E, F; 6669B, D, F; 6717B; 6718B, C, E, F, G; 6719B; 6768B; 6769I, J.

Note. Except for the aerial extent, the text or wording in Stipulations 6a and 6b are identical. If both stipulations are selected, they may be combined. Their locations are shown on Map 3.

Summary of the Effectiveness of Stipulation No. 6b. Stipulation 6b prohibits permanent facilities within the 10-mile radius shoreward of the barrier islands, unless the lessee demonstrates to the satisfaction of the MMS Regional Director, in consultation with the North Slope Borough and the Alaska Eskimo Whaling Commission, that the development will not preclude reasonable subsistence access. This stipulation would reduce the potential for collisions with oil and gas facilities for marine and coastal birds, including the spectacled and Steller's eiders. This stipulation would provide little protection to subsistence-whaling activities, because the whale migration and most whale hunting (based on the whale-strike data) take place outside the barrier islands, not inside. This stipulation would provide little or no additional protection to subsistence whaling or bowhead whales from that provided by Stipulation 5. The increased protection offered by this stipulation to marine and coastal birds, including the spectacled and Steller's eiders, to eliminate potential collisions with offshore oil and gas facilities is not significant to the populations of concern.

II.H.2.c. Stipulation No. 7 - Pre-Booming Requirements for Fuel Transfers

Fuel transfers (excluding gasoline transfers) of 100 barrels or more occurring 3 weeks prior to or during the bowhead whale migration will require pre-booming of the fuel barge(s). The fuel barge must be surrounded by an oil-spill-containment boom during the entire transfer operation to help reduce any adverse effects from a fuel spill. This stipulation is applicable to the blocks and migration times listed in the stipulation on Industry Site-Specific Bowhead Whale-Monitoring. The Lessee's oil-spill-contingency plans must include procedures for the pretransfer booming of the fuel barge(s).

Summary of the Effectiveness of Stipulation No. 7. This stipulation would lower the potential effects to water quality, lower trophic-level organisms, subsistence resources, and sociocultural systems by providing additional protection to the bowhead whale from potential fuel spills that may occur just prior to or during the bowhead whale-migration period. This stipulation would be an added caution to further reduce the chance of any fuel spill contacting a bowhead whale. It would moderate the adverse effects of a fuel spill to water quality. Such a spill is unlikely to occur; however, if it did occur just prior to or during the whale migration, it could result in adverse impacts to the bowhead whale and subsistence hunting. This stipulation would be effective in reducing those risks of harm to a whale or that a harvested whale may be tainted from a potential spill by containing any potential spill within the boom area. This requirement applies only to period just prior to and during the whale-migration period. A similar procedure is part of the Northstar fuel-transfer plan.

II.H.2.d. Stipulation No. 8 – Lighting of Lease Structures to Minimize Effects to Spectacled and Steller's Eiders

To minimize the likelihood that migrating spectacled or Steller's eiders will strike lease structures associated with offshore drilling, all structures so identified by MMS, must be lighted and/or marked in a manner that does not attract them and minimizes the likelihood they would collide with the structures. The MMS and the Fish and Wildlife Service will cooperatively develop lighting requirements and identify where, when, and on what type of structures the requirements should be applied. Specific lighting requirements will be developed by April 1, 2004, at which time MMS will issue these requirements.

The radiation of light outward from structures must be minimized by shading and/or light fixture placement to direct light inward and downward to living and work surfaces while minimizing light radiating upward and outward. These requirements will not apply between October 31 and May 1 of each year, when eiders are not likely to be present.

Lessees are required to report Steller's and/or spectacled eiders injured or killed through collisions with lease structures, to the Fairbanks Fish and Wildlife Field Office, Endangered Species Branch, Fairbanks, Alaska at (907) 456-0499 for instruction on the handling and disposal of the injured or dead bird.

Summary of the Effectiveness of Stipulation No. 8. The Biological Opinion issued by the Fish and Wildlife Service specifies a reasonable and prudent measure necessary and appropriate to minimize potential adverse impacts to this species. To be exempt from the prohibitions of Section 9 of the Act, the MMS must comply with the terms and conditions identified in the Biological Opinion. This stipulation requires all structures to be lighted and/or marked to improve visibility to migrating spectacled and Steller's eider, the minimization of outward radiating light, and the reporting of any injured or killed spectacled or Steller's eider. The lighting requirements do not apply between October 31 and May 1 of each year, when eiders are not likely to be present.

A lighting strategy will be developed jointly by the MMS and the Fish and Wildlife Service using available information on bird-avoidance measures. This strategy will be modified, as appropriate, if significant new information on bird-avoidance measures becomes available during activities covered by this consultation. Modification will be developed jointly by the MMS and the Fish and Wildlife Service.

This stipulation could reduce the potential for spectacled and Steller's eiders to strike structures, which would lessen the potential effects of OCS exploration and development on these species.

II.H.3. Standard Information to Lessee Clauses

Information to Lessee clauses 1 through 16 are standard and apply to OCS activities in the Beaufort Sea. They are considered part of the proposed action and alternatives for the Beaufort multiple-sale EIS for analysis purposes.

No. 1 - Information on Community Participation in Operations Planning
No. 2 - Information on Kaktovikmiut Guide *In this Place*
No. 3 - Information on Nuiqsutmiut Paper
No. 4 - Information on Bird and Marine Mammal Protection
No. 5 - Information on River Deltas
No. 6 - Information on Endangered Whales and MMS Monitoring Program
No. 7 - The Availability of Bowhead Whales for Subsistence-Hunting Activities
No. 8 - Information on High-Resolution Geological and Geophysical Survey Activity
No. 9 - Information on Polar Bear Interaction
No. 10 - Information on the Spectacled Eider and Steller's Eider
No. 11 - Information on Sensitive Areas to be Considered in Oil-Spill-Contingency Plans
No. 12 - Information on Coastal Zone Management
No. 13 - Information on Navigational Safety
No. 14 - Information on Offshore Pipelines
No. 15 - Information on Discharge of Produced Waters
No. 16 - Information on Use of Existing Pads and Islands

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 contingency 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 Kaktovikmiut Guide *In This Place*. The people of Kaktovik, the Kaktovikmiut, have compiled "A Guide for Those Wishing to Work in The Country of the Kaktovikmiut." The guide's intent, in part, is to provide information that may promote a better understanding of their concerns. Lessees are encouraged to obtain copies of the guide and to incorporate it into their Orientation Program to assist in fostering sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which they will be operating.

No. 3 - Information on Nuiqsutmiut Paper. The people of Nuiqsut, the Nuiqsutmiut, have compiled a paper for people working in their country. The paper provides information that may promote a better understanding of their concerns. Lessees are encouraged to obtain copies of the paper and to incorporate it into their Orientation Program to assist in fostering sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which they will be operating.

No. 4 - 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 are also 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 March 31, 2003 (50 CFR 18.123 et seq.). 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.

No. 5 - Information to Lessees on River Deltas. Lessees are advised that certain river deltas of the Beaufort Sea coastal plain (such as the Kongakut, Canning, and Colville) have been identified by the FWS as special habitats for bird nesting and fish overwintering areas, as well as other forms of wildlife. Shore-based facilities in these river deltas may be prohibited by the permitting agency.

No. 6 - Information on Endangered Whales and MMS Monitoring Program. Lessees are advised that the MMS intends to continue its area wide endangered bowhead whale monitoring program in the Beaufort Sea. The program will gather information on whale distribution patterns which will be used by MMS and others to assess impacts on bowhead whales.

The MMS will perform an environmental review for each proposed exploration plan and development and production plan, including an assessment of cumulative effects of noise on endangered whales. Should the review conclude that activities described in the plan will be a threat of serious, irreparable, or immediate harm to the species, the RS/FO will require that activities be modified, or otherwise mitigated before such activities would be approved.

Lessees are further advised that the RS/FO has the authority and intends to limit or suspend any operations, including preliminary activities, as defined under 30 CFR 250.201, on a lease whenever bowhead whales are subject to a threat of serious, irreparable, or immediate harm to the species. Should the information obtained from MMS or lessees' monitoring programs indicate that there is a threat of serious, irreparable, or immediate harm to the species, the RS/FO will take action to protect the species. The RS/FO may require the lessee to suspend operations causing such effects, in accordance with 30 CFR 250.168. Any such suspensions may be terminated when the RS/FO determines that circumstances which justified the ordering of suspension no longer exist.

No. 7 - Information on the Availability of Bowhead Whales for Subsistence Hunting Activities. Lessees are advised that the NMFS issues regulations for incidental take of marine mammals, including bowhead whales. Incidental take regulations are promulgated only upon request and the NMFS must be in receipt of a petition prior to initiating the regulatory process. Incidental takes of bowhead whales are allowed only if an LOA or an IHA is obtained from the NMFS pursuant to the regulations in effect at the time. An LOA or an IHA must be requested annually. In issuing an LOA or an IHA, the NMFS must determine that proposed activities will not have an unmitigable adverse effect on the availability of the bowhead whale to meet subsistence needs by causing whales to abandon or avoid hunting areas, directly displacing subsistence users, or placing physical barriers between whales and subsistence users.

Lessees are also advised that, in reviewing proposed exploration plans which propose activities during the bowhead whale migration, the MMS will conduct an environmental review of the potential effects of the activities, including cumulative effects of multiple or simultaneous operations, on the availability of the bowhead whale for subsistence use. The MMS may limit or require operations be modified if they could result in significant effects on the availability of the bowhead whale for subsistence use.

The MMS and the NMFS will establish procedures to coordinate results from site-specific surveys required by Stipulation No. 4 and NMFS LOA's or IHA's to determine if further modification to lease operations are necessary.

No. 8 - Information on High-Resolution Geological and Geophysical Survey Activity. Lessees are advised of the potential effect of geological and geophysical (G&G) activity to bowhead whales and subsistence hunting activities. High resolution G&G surveys are distinguished from 2-D and 3-D geophysical 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 G&G 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. The 2-D and 3-D geophysical surveys are typically conducted prior to lease sales.

Lessees are advised that all G&G survey activity conducted in the Beaufort Sea Planning Area, either under the pre-lease permitting regulations at 30 CFR 251, or as part of an approved exploration or development and production plan under 30 CFR 250, is subject to environmental and regulatory review by the MMS. It is the intention of MMS to treat pre-lease G&G activities in a manner similar to the post-lease G&G activities. The MMS has standard mitigating measures which are applied to these activities, and lessees are encouraged to review these measures before developing their applications for G&G permits. Copies of the non-proprietary portions of all G&G permit applications will be provided by MMS to the NSB, the AEWC, and directly affected subsistence communities for comment. 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 G&G surveys to minimize unreasonable conflicts between the G&G survey and subsistence whaling activities.

Lessees and applicants are advised that MMS will require any proposed G&G activity to be coordinated with directly affected subsistence communities, the NSB, and the AEWC 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 directly affected subsistence communities, the NSB, and the AEWC for comment.

No. 9 - 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.

No. 10 - 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 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 and Beaufort seas 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. 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 the spectacled eider and the Steller's eider and their habitats are protected.

No. 11 - Information on Sensitive Areas to be Considered in the Oil-Spill Contingency Plans (OSCP) Lessees are advised that certain areas are especially valuable for their concentrations of marine birds, marine mammals, fishes, other biological resources, or cultural resources, and for their importance to subsistence harvest activities, and should be considered when developing OSCP's. Identified areas and time periods of special biological and cultural sensitivity include:

(1) the lead system off Point Barrow, April-June;

(2) the salt marshes 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; (Leffingwell Cabin, a National Historic Site, is located on Flaxman Island);

(11) the Jones Island Group (Pingok, Spy, and Leavitt Islands) and Pole Island are known polar bear denning areas, November-April; and

(12) the Sagavanirktok River delta, January-December.

These areas are among areas of special biological and cultural sensitivity to be considered in the OSCP required by 30 CFR 250.300. Lessees are advised that they have the primary responsibility for identifying these areas in their OSCP's 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.

No. 12 – Information on Coastal Zone Management. MMS advises lessees that under the Coastal Zone Management Act (16 U.S.C. 1451 et. seq., Section 307), as amended, a State with an approved Coastal Zone Management (CZM) Plan reviews certain OCS activities to determine whether they will be conducted in a manner consistent with their approved CZM plan. This review authority is applicable to activities described in OCS exploration plans and development and production plans that affect any land or water use or natural resource within the State's coastal zone. Generally, the MMS may not issue a permit for activities described in a plan unless the State concurs or is conclusively presumed to have concurred that the plan is consistent with its CZM plan. In cases where concurrence is not given or presumed, the matter may be appealed to the Secretary of Commerce.

The Department of Commerce, National Oceanic and Atmospheric Administration revised the regulations at 15 CFR 930 implementing the Federal consistency provisions of the Coastal Zone Management Act effective January 8, 2001. These revised regulations were published in the Federal Register on December 8, 2000, at 65 FR 77124, et. seq.

The Alaska Coastal Management Plan includes Statewide standards found in 6 AAC 80 and enforceable policies found within approved coastal district programs. For the Beaufort Sea OCS mineral lease sales, the enforceable policies of the North Slope Borough Coastal Management Program and the Statewide standards are applicable.

No. 13 - Information on Navigational Safety. Operations on some of the blocks offered for lease may be restricted by designation of fairways, precautionary zones, anchorages, safety zones, or traffic separation schemes established by the USCG pursuant to the Ports and Waterways Safety Act (33 U.S.C. 1221 et seq.), as amended. Lessees are encouraged to contact the USCG regarding any identified restrictions. The U.S. Army Corps of Engineers permits are required for construction of any artificial islands, installations, and other devices permanently or temporarily attached to the seabed located on the OCS in accordance with Section 4(e) of the OCSLA, as amended.

For additional information, prospective bidders should contact the U.S. Coast Guard, 17th Coast Guard District, P.O. Box 3-5000, Juneau, Alaska 99802, (907) 586-7355. For Corps of Engineers information, prospective bidders should contact U.S. Army Corps of Engineers, Alaska District, Regulatory Branch (1145b), P.O. Box 898, Anchorage, Alaska 99506-0898, (907) 753-2724.

No. 14 - Information on Offshore Pipelines. Lessees are advised that the Department of the Interior and the Department of Transportation have entered into a Memorandum of Understanding, dated December 10, 1996, concerning the design, installation, and maintenance of offshore pipelines. See also CFR 250.1000(c)(1). Bidders should consult both departments for regulations applicable to offshore pipelines. Copies of the MOU are available from the MMS Internet site and the MMS Alaska OCS Region.

No. 15 - Information on Discharge of Produced Waters. Lessees are advised that the State of Alaska prohibits discharges of produced waters on State tracts within the ten-meter depth contour. Discharges of produced waters into marine waters are subject to conditions of National Pollutant Discharge Elimination System permits issued by the EPA, and may also include a zero-discharge requirement on Federal tracts within the ten-meter contour.

No. 16 - Information on Use of Existing Pads and Islands. During the review and approval process for exploration and development and production plans, MMS will encourage lessees to use existing pads and islands wherever feasible.

Summary of the Effectiveness of the ITL Clauses. The effectiveness of the above ITL clauses varies. The primary purpose or focus of all of these ITL clauses is to provide the lessee with information about the requirements or mitigation required by other Federal and State agencies. The ITL clauses themselves provide no mitigation. However, the regulations and mitigation required by the other agencies are effective and do lower potential adverse impacts from proposed oil and gas activities. To the extent that the ITL clauses enlighten lessees and their contractors to these mitigative measures, then the ITL clauses also may be considered effective.

II.H.4. Other Information to Lessee Clauses Developed for Consideration in this EIS

No. 17 - Information to Lessees on Archaeological and Geological Hazards Reports and Surveys. Lessees are referred to the regulations at 30 CFR 250.194, Archaeological Reports and Surveys, and 30 CFR 250.203(b)(1)(ix) for geologic hazard surveys and reports. Following is a list of specific blocks in the Beaufort Sea Planning Area on which an archaeological resource may exist and for which an archaeological report will be required.

> OPD: NR 05-01, Dease Inlet: Blocks: 6604-6606, 6654-6657, 6704-6709, 6754-6761, 6804-6812, 6856-6864, 6909-6915, 6960-6969, 7011-7023, 7062-7073, 7113-7123

OPD: NR 05-02, Harrison Bay North; Blocks: 7001-7007, 7051-7059, 7101-7112

OPD: NR 05-03, Teshekpuk: Blocks: 6015-6024, 6067-6072

OPD: NR 05-04, Harrison Bay: Blocks: 6001-6015, 6052-6066, 6106-6115, 6157-6168, 6208-6223, 6258-6274, 6309-6324, 6360-6374, 6410-6424, 6461-6471, 6513-6519, 6565-6566

OPD: NR 06-03, Beechey Point: Blocks: 6202-6207, 6251-6257, 6301-6308, 6351-6361, 6401-6417, 6456-6469, 6509-6520, 6561-6570, 6612-6614, 6616, 6618-6623, 6664-6674, 6717-6724, 6768-6771, 6819-6822, 6870-6871

OPD: NR 06-04, Flaxman Island: Blocks: 6651, 6701-6702, 6751-6754, 6802-6808, 6857-6860, 6910-6912, 6920-6924, 6961-6974, 7013-7022, 7066-7070, 7118-7119

OPD: NR 07-03, Barter Island: Blocks: 6853-6855, 6901-6909, 6958-6960, 7010-7011, 7061-7063, 7113-7114

OPD: NR 07-05, Demarcation Point: Blocks: 6016-6017, 6067-6069, 6118-6120, 6169-6170, 6222-6223, 6273-6275, 6324-6325

The regulations at 30 CFR 250.203(b)(1)(ix) require a shallow hazards report be included in all Exploration Plans (EPs) or Development and Production Plans (DPPs) at the time they are submitted to MMS for completeness review. In addition, for the blocks listed above, lessees must include a final archaeological resources report as required by 30 CFR 250.194 as part of any EP or DPP submitted to MMS for completeness review. Lessees are encouraged to combine surveys whenever feasible. The MMS will not consider a plan complete or initiate the regulatory review process without these documents.

Lessees may not set a drilling or production facility on location until MMS has approved an EP or DPP. Lessees are advised that seasonal constraints may prevent the following from occurring in the same year: collection of required data, obtaining of any necessary permits and coastal consistency certification, and the initiation of operations including mobilization and set down of the facility at location. Lessees are encouraged to plan accordingly.

Summary of the Effectiveness of the ITL Clause No. 17 - Information to Lessees on Archaeological and Geological Hazards Reports and Surveys. The primary purpose or focus of all of these ITL clauses is to provide the lessee with information about the requirements to protect potential prehistoric and historic archaeological sites. The ITL clause provide no mitigation; however, it does enlighten lessees and their contractors to the existence of regulations, and that reports and surveys will be required as part of their exploration and development plans when they are submitted. The existing laws and regulation provide mitigation for archaeological sites through the identification of potential sites and recommend avoidance when possible.

II.H.5. Other ITL Clauses Considered in this EIS

During the preparation of the draft EIS, the MMS evaluated the merits of adding an ITL clause to encourage lessees to consider noise-abatement methods, if needed, to reduce activity noise that may occur during and in the vicinity of the whale migration. However, no one commented on the merits of such an ITL, either in the hearings or through written comments. While lessees and operators may choose to incorporate noise-abatement techniques into their facility and equipment designs, the MMS did not find any merit in developing a mitigating measure or requirement at this time. This type of requirement may be considered and evaluated later during the environmental assessment of exploration and development plans.

II.I. Description of the Agency-Preferred Alternative

The National Environmental Policy Act (NEPA) Council on Environmental Quality regulations require an agency-preferred alternative be identified in the final EIS. The MMS has reviewed our analysis of the alternatives in the EIS, comments received on the draft EIS, and other pertinent information and developed the MMS Agency-Preferred Alternative. The MMS Agency-Preferred Alternative is the Proposal for Alternative I, the 2002 -2007 program area with 5 standard stipulations, 2 optional stipulations, 16 standard ITL clauses, and one optional ITL Clause.

Stipulation No. 1 - Protection of Biological Resources
Stipulation No. 2 - Orientation Program
Stipulation No. 3 - Transportation of Hydrocarbons
Stipulation No. 4 - Industry Site-Specific Bowhead Whale-Monitoring Program
Stipulation No. 5 - Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence Activities
Stipulation No. 7 - Pre-Booming Requirements for Fuel Transfers
Stipulation No. 8 - Lighting of Structures to Minimize Effects to Spectacled and Steller's Eiders]

ITL No. 1 - Information on Community Participation in Operations Planning
ITL No. 2 - Information on Kaktovikmiut Guide *In this Place*
ITL No. 3 - Information on Nuiqsutmiut Paper
ITL No. 4 - Information on Bird and Marine Mammal Protection
ITL No. 5 - Information to Lessees on River Deltas
ITL No. 6 - Information on Endangered Whales and the MMS Monitoring Program
ITL No. 7 - Information on the Availability of Bowhead Whales for Subsistence-Hunting Activities
ITL No. 8 - Information on High-Resolution Geological and Geophysical Survey Activity
ITL No. 9 - Information on Polar Bear Interaction
ITL No. 10 - Information on the Spectacled Eider and the Steller's Eider
ITL No. 11 - Information on Sensitive Areas to be Considered in Oil-Spill-Contingency Plans
ITL No. 12 - Information on Coastal Zone Management
ITL No. 13 - Information on Navigational Safety
ITL No. 14 - Information on Offshore Pipelines
ITL No. 15 - Information on Discharge of Produced Waters
ITL No. 16 - Information on Use of Existing Pads and Islands
ITL No. 17 - Information to Lessees on Archaeology and Geological Hazards Reports and Surveys

Section IV.C analyzes effects on the 16 different resource categories in by alternative and by sale. Sections IV.D through IV.H are general topics common to all resources. Section IV.I analyzes the effects of a low-probability, very large oil spill. Section V discusses the effects of cumulative impacts as defined by NEPA. Section V.C analyzes the cumulative effects on the same 16 resources.

Section II.H describes the Mitigating Measures that are incorporated as part of this Agency-Preferred Alternative. Standard Stipulations are described in Section II.H.1, and Other Stipulations Developed for Consideration in the EIS are described in Sections II.H.2.a through Section II.H.2.c. Standard ITL's are described in Section II.H.3, and other ITL Clauses Considered in the EIS are described in Section II.H.4.

Adopting specific stipulations and ITL's provides environmental protection to minimize the environmental effects. The Agency-Preferred Alternative is almost the same as Alternative I, a separate analysis is not included, because it basically would repeat the entire Alternative I analysis. We suggest interested readers review summary tables II.A-4, II.A-5, and II.A-6 and the summary of the effectiveness of Stipulations No. 7 and No. 8 and ITL No. 17 in Sections II.H.2 and II.H.4. If the reader wants additional information, it can be found in the full analysis of effects by resource in Sections IV.C and V.C.

This information is provided to meet the Council on Environmental Quality regulations and should not be considered as the final decision or as approval of the project. The MMS will develop its final Record of Decision for Sale 186 following the distribution of the final EIS and the Proposed Notice of Sale. The final decision(s) for Sales 186, 195, and 202 and supporting rationale may be different than the Agency-Preferred Alternative.

If the Secretary of the Interior decides to proceed with each of the sales (186, 195, and 202), by not choosing Alternative II - No Lease Sale, the Secretary may choose one, all, some combination, or part of the deferral options to comprise the final Notice for Sale 186. The Secretary will have the full suite of options available for Sales 195 and 202 when those decisions are made in 2005 and 2007, respectively. The Secretary may choose the same options selected for Sale 186 or different options.

SECTION III

DESCRIPTION OF THE AFFECTED ENVIRONMENT

Contents for Section III

III. Description of the Affected Environment

In this section, we describe the environment that the proposed leasing action and the alternatives would affect. This description of the affected environment is supplemented by other EIS's that describe the existing environment for the Beaufort Sea and North Slope area. This includes the final EIS's for Sales BF and 71 (USDOI, BLM, Alaska OCS Office, 1979, 1982) and 87, 97, 124, 144, and 170 (USDOI, MMS, 1984, 1987, 1990a, 1996a, 1998), which are incorporated by reference. Included also are information in the EIS's for the Northstar Development Project (U.S. Army Corps of Engineers, 1999) and the Liberty Development Project (USDOI, MMS, Alaska OCS Region, 2002a). Summaries of these descriptions, supplemented by additional material, as cited, follow.

A. PHYSICAL CHARACTERISTICS OF THE BEAUFORT SEA PLANNING AREA

The following six resource categories describe the physical environment:

- Geology
- Climate and Meteorology
- Oceanography
- Sea Ice
- Chemical Oceanography and Water Quality
- Air Quality

III.A.1. Geology

III.A.1.a. Petroleum Geology of the North Slope Province

Past Petroleum Activities. The North Slope of Alaska is a rich petroleum province with 24 producing oil fields, including Prudhoe Bay, the largest field ever discovered in North America (Figure III.A-1). Current estimates by the State of Alaska report that original North Slope oil reserves were 19.2 billion barrels (State of Alaska, Dept. of Natural Resources, 2000), of which 13 billion barrels has been carried through the Trans-Alaska Pipeline System to outside markets since 1977. Industry has estimated that another 5 billion barrels of oil could be found in satellite fields near present North Slope infrastructure. Oil production from northern Alaska is transported south through the 800-mile Trans-Alaska Pipeline to Valdez, Alaska where it is loaded on marine tankers bound for the U.S. West Coast and Pacific Rim markets. After reaching a peak in 1988 at slightly more than 2.0 million barrels per day, the present production from fields in northern Alaska is approximately 1.0 million barrels per day. Although discovered natural gas resources total nearly 35 trillion cubic feet, gas has not been exported from the North Slope because there is no gas-transportation system. Numerous proposals are being considered to commercialize the natural gas in northern Alaska; however, it is unlikely that North Slope gas will be delivered to markets before 2008.

Exploration of northern Alaska dates back to the 1920's in the Brooks Range foothills in areas now included in the National Petroleum Reserve-Alaska. The first significant oil discovery was at Umiat in 1946 during the Navy drilling program. The first competitive lease sale on Federal land was held in 1958 by the Bureau of Land Management near the Umiat (oil) and Gubik (gas) discoveries in the southeastern National Petroleum Reserve-Alaska. The first competitive lease sale for State lands on the North Slope was held in 1964, and a series of major discoveries were made in the next few years (Prudhoe Bay in 1968, Kuparuk in 1969, Milne Point in 1970). Since then, the State of Alaska has held 35 sales on the North Slope and nearshore Beaufort Sea. Full-scale oil production began in 1977 after the completion of the pipeline.

The first offshore lease sale was held in 1979, offering nearshore State and Federal tracts in the Beaufort Sea. As a result of this sale, several large oil fields were discovered, including Endicott/Duck Island (582 million barrels), Seal Island/Northstar (175 million barrels), Niakuk (115 million barrels), and Tern/Liberty (120 million barrels). Endicott was the first offshore facility constructed in the Beaufort Sea, and production started there in 1987. Northstar is the second production facility located offshore; it began production in late 2001. Liberty was expected to be the third offshore facility, but it has been suspended. All of these offshore fields are produced from manmade gravel islands in relatively shallow water (less than 40 feet).

Following the initial discoveries in the nearshore Beaufort Sea, a series of offshore lease sales were held by the Federal Government beginning in 1982. In Sale 71 (1982), bonus bids totaling $2.067 billion reflected industry expectations for the Beaufort Sea, particularly for the Mukluk Prospect in Harrison Bay. A single dry well on Mukluk condemned this large prospect and was a severe blow to hopes of finding another Prudhoe Bay-sized field offshore. Five more Federal OCS lease sales have been held (Sale 87 in 1984; Sale 97 in 1988; Sale 124 in 1991; Sale 144 in 1996; Sale 170 in 1999), resulting in a total of 688 tracts leased for $3.6 billion (Figure III.A-2). Thirty exploration wells were drilled to test 20 prospects on Federal tracts in the Beaufort Sea Planning Area. Nine exploration wells are listed as "capable of producing in paying quantities," and five fields have been considered for commercial development (Northstar, Sandpiper, Hammerhead, Kuvlum, and Liberty). With the exception of Northstar and Liberty, all other discoveries were considered noncommercial and the tracts were relinquished. After more than 2 decades of leasing and exploration in the Beaufort Sea, production has just begun from Federal OCS tracts (Northstar).

III.A.1.b. Geologic History

Northern Alaska has a geologic history spanning hundreds of millions of years (Figure III.A-3). Several tectonic episodes have rearranged the configuration of geologic basins and produced conditions favorable to forming oil and gas pools. Large structural features are now concealed beneath the nearly flat coastal plain and offshore continental shelf (Figure III.A-4). A discussion of the geologic history of the Beaufort Shelf is contained in Grantz and May (1982); Craig, Sherwood, and Johnson (1985); and Hubbard, Edrich, and Rattey (1987). In middle to late Devonian time, a mountain-building event (orogeny) deformed and metamorphosed Precambrian to early Paleozoic strata grouped into the Franklinian sequence (Figure III.A-3). These rocks generally form the basement complex for both seismic data (no coherent seismic signals) and economic potential (no prospective reservoirs). In some areas on the eastern Beaufort shelf, however, the Franklinian sequence is less deformed and could hold oil/gas pools.

From Late Devonian to Jurassic time, sediments were shed southward from a northern highland onto a south-facing continental shelf. Nonmarine sediments of the Endicott Group, marine carbonates of the Lisburne Group, clastics of the Sadlerochit group, and carbonates and clastics of the Shublik and Sag River formations are grouped into the Ellesmerian Sequence (Figure III.A-3).

In mid-Jurassic time, the old continental margin began to uplift and break apart (rift) along a trend roughly parallel to the present Beaufort Sea coastline. The northern landmass moved away from Alaska leaving behind the present Arctic Ocean basin. Uplift associated with the rift event eroded the Ellesmerian sequence and resulted in regional unconformities that are key elements in many of the North Slope oil and gas fields (Figure III.A-4). A series of fault-bounded rift basins became local depocenters for sediments of the Kingak and Kuparuk formations. These strata are grouped into the Rift Sequence (MMS terminology) and are equivalent to the Beaufortian Sequence of Hubbard, Edrich, and Rattey (1987) (Figure III.A-3).

Coincident with continental rifting, tectonic activity began in the area of the Brooks Range to the south. The ancestral Brooks Range was formed from older terranes pushed northward. The mountain belt shed sediments to the north into a deep geologic basin (Colville basin, Figure III.A-4). The Colville basin formed as an east-west trough parallel to the orogenic belt and was filled with deltaic and marine strata during Cretaceous time. These clastic strata are grouped into the Brookian sequence (Figure III.A-3). The lower part of the sequence contains a thick sequence of deepwater shales and turbidite sands assigned to the Torok Formation. The upper part of the deltaic sequence contains shallow marine to nonmarine sediments assigned to the Nanushuk and Colville groups (Figure III.A-3).

By mid-Cretaceous time, seafloor spreading fully opened the arctic oceanic basin flanking Alaska to the north. The Beaufort continental margin was defined by a series of down-to-the-north faults along a regional flexure informally called the “Hinge Line” that marks the transition from continental crust (older sedimentary rocks) to oceanic crust (younger volcanic rocks). A broad basement ridge (the Barrow Arch) separates the Colville basin in the south and the continental margin facing the present-day Arctic Ocean (Figure III.A-4). The Barrow Arch trends roughly parallel to the modern Beaufort Sea coastline from the Canning River westward into the Chukchi Sea. The majority of North Slope fields lie along the crest of the Barrow Arch, because it acted as a focal point for oil migration from surrounding geologic basins.

By late Cretaceous time, sediments of the Brookian Sequence prograded across the Barrow Arch and began to fill the fault-bounded basins on the continental margin. In late Cretaceous and Tertiary time, the basins were progressively filled in a generally northeastward direction. Rapid deposition from delta systems produced large-scale gravity faults that trend subparallel to the present continental shelf break.

From early Tertiary time to the present, orogenic activity in the Brooks Range moved northward. By the mid-Tertiary, structural deformation reached the eastern Beaufort shelf and produced the complex structural features from Camden Bay to the northern Yukon province.

III.A.1.c. Coastal Physiography

The Arctic Coastal Plain is a vast, low-angle sloping plain that extends north from the Brooks Range to the Beaufort Sea. It varies in width from about 105 miles (170 kilometers) in the central coast to its narrowest near the border with Canada, where the Brooks Range is only about 10 miles (16 kilometers) from the coast. This tundra-covered, frozen plain exhibits many permafrost features such as pingos, ice wedges, thaw lakes, and patterned ground. Rivers dissect the plain and form deltas along the coast, the largest being the Colville Delta. Deltas contain features such as distributary channels, small islands, barrier bars, spits, and lagoons. Typical coastal features include bluffs, terraces, wave-cut cliffs, and beach ridges.

Across the Beaufort Sea coast, average rates of erosion vary from 1.5-4.7 meters per year (5-15.4 feet per year) (see USDOI, MMS, Alaska OCS Region, 2002a:Figure VI.C-2), and short-term rates of 30 meters (98 feet) per year have been measured (Hopkins and Hartz, 1978a). Wave action and thermokarst erosion lead to generally higher erosion rates on bluffs, headlands, and coastal segments consisting of fine-grained and permafrost material. River deltas are prograding features and do not show any net erosion.

III.A.1.d. Offshore Shallow Geology

Shallow geological and geophysical data provide information about marine geology, archaeology, geotechnical and engineering considerations, and the substrate for critical biological habitats on the outer continental shelf. These data also provide invaluable insight into past climate and sea levels. The term “shallow” usually means a depth from the seafloor to about 1,000 feet (300 meters), which normally includes Pleistocene and Holocene sediments of the Quaternary Period. In the following discussion, shallow geological data include maps, diagrams of cross-sections and boreholes, and data from rock or sediment samples; the geophysical data are mainly high-resolution seismic-reflection records from instruments such as side-scan sonars (aerial-type views), fathometers, subbottom profilers, boomers, mini-sparkers, and air- or waterguns (all cross-sectional records with variable power, penetration, and resolution).

Previous Work: The Beaufort Sea area is one of most studied shelves in the world. The most recent studies have been primarily for the oil and gas industry, but a great abundance of older publications on the Beaufort Sea describe the regional and shallow geology (Dinter, Carter, and Brigham-Grette, 1990; Craig, Sherwood, and Johnson, 1985). Older but very exhaustive information also is found in research reports by the U.S. Geological Survey in specific areas or on specific objectives (Barnes, Rearic, and Reimnitz, 1985; Barnes, McDowell, and Reimnitz, 1977, 1978; Barnes and Reimnitz, 1974, 1979; Barnes, Schell, and Reimnitz, 1984; Black, 1964; Boucher, Reimnitz, and Kempema, 1980; Bruggers and England, 1979; Dinter, 1982, 1985; Dunton, Reimnitz, and Schonberg, 1982; Grantz et al., 1980, 1982; Grantz and Dinter, 1980; Grantz, Dinter, and Biswas, 1983; Grantz and Eittreim, 1979; Greenberg, Hart, and Grantz, 1981; Hopkins and Hartz, 1978a; Hopkins, 1967; Hunter and Hobson, 1974; Reimnitz et al., 1980, 1982; Reimnitz and Bruder, 1972; Reimnitz, Graves, and Barnes, 1985; Reimnitz and Kempema, 1982a,b; Reimnitz and Maurer, 1978a; Reimnitz, Rodeick, and Wolf, 1974; Reimnitz and Ross, 1979; Reimnitz, Toimil, and Barnes, 1978; Rodeick, 1979; Rogers and Morack, 1978; and Wolf, Reimnitz, and Barnes, 1985).

The Bureau of Land Management and, subsequently, the Minerals Management Service's Outer Continental Shelf Environmental Assessment Program, funded many geological and geophysical studies of the Beaufort Sea (Aagaard, 1981; Barnes and Reiss, 1981; Barnes, 1981; Barnes and Hopkins, 1978; Barnes and Rearic, 1983, 1985, 1986; Barnes, Rearic, and Reimnitz, 1983; Barnes and Reimnitz, 1980; Barry, 1979; Biswas and Gedney, 1978, 1979; Briggs, 1983; Brower, Searby, and Wise, 1977; Cannon, 1981; Dunton and Schonberg, 1983; Harrison and Osterkamp, 1981; Hartz and Hopkins, 1980; Hopkins and Hartz, 1978b; Hopkins, 1981; Hunter and Reiss, 1983; Kempema, 1983; Lewbel 1984; Naidu et al., 1982; Osterkamp and Harrison, 1978a,b; Osterkamp and Payne, 1981; Phillips et al., 1985a,b; Phillips and Reiss, 1983a,b; Pritchard, 1978; Reimnitz, Barnes, and Phillips, 1983; Reimnitz et al., 1979; Reimnitz and Maurer, 1978b; Reimnitz, Ross, and Barnes, 1979; Rogers and Morack, 1981, 1982; Sellman, Neave, and Chamberlain, 1981; Stringer, 1982; and Wolf, Barnes, and Reimnitz, 1983).

Industry also has collected site-specific geological data (Miller, 1996, 1997, 1998, 1999; Harding Lawson Assocs., 1981a, 1985, 1988; Woodward-Clyde Consultants, 1981, 1982; EBA Engineering Inc., 1991, 1996; Dames and Moore, 1983a,b, 1985a,b, 1993; Fairweather E&P Services, 1997a,b; ENSR Consulting and Engineering, 1990; Northern Technical Services, 1985) and geophysical data (Arctic Geoscience, Inc., 1997; Blanchet et al., 2000; Coastal Frontiers Corporation, 1996, 1997, 1998a,b,c, 1999; Comap Geophysical Surveys, 1983, 1985a,b; Dames and Moore, 1983a,b,c, 1984, 1985a,b,c; Deepsea Development Services (SAIC), 1993, 1994; Fairweather E&P Services, 1997; Fugro-McClelland, 1990, 1992; Harding Lawson Associates, 1981, 1983, 1985, 1988; LGL Ecological Research Assocs., Inc., 1998; McClelland-EBA Inc., 1986; Northern Technical Services, 1985a,b; Pelagos Corporation, 1987, 1990a,b,c; and Watson Company, 1998, 1999) for geologic hazards analysis (Thurston, Choromanski, and Crandall, 1999). These industry data sets, illustrated in Figure III.A-5, have been combined into a public GIS database (USDOI, MMS, 2002b).

III.A.1.d(1) Quaternary Geological History

The Quaternary geological history of most of Alaska (approximately the last 2 million years) generally reflects the advance and retreat of large glaciers and the direct effects of glacial processes. However, in the Beaufort Sea area, glaciers played only a small or indirect role in shaping the physical environment. Glaciation generally was limited to alpine and mountain-front glaciers and reached the present-day coast perhaps only in the east near Camden Bay during the Pleistocene. Much more influential in the Quaternary history and geomorphology along the Beaufort Sea coast were the processes associated with glacial and eustatic sea-level fluctuations.

Since the late Pleistocene, sea level has fluctuated from 21-30 feet (7-10 meters) higher than today (about 70,000 years ago), to 270 feet (90 meters) or more lower than today (18,000 years ago) (see USDOI, MMS, Alaska OCS Region, 2002a:Table VI.C-2).

At the lowstand 18,000 years ago, the paleo-shoreline was seaward of the present-day barrier islands. Sea level generally has risen from 18,000 years ago until today, with a few notable times when it leveled off or retreated and drowned, eroded, and buried onshore features such as river channels, lagoons, paleo-shorelines and associated coastal features, permafrost and related features, and organic deposits. About 13,000 years ago, sea level stood at minus 165 feet (minus 50 meters), corresponding to the late Wisconsin glacial advance and, near the beginning of the Holocene 11,000 years ago, it began to rise to its present position, which was reached about 5,000 years ago.

It commonly is assumed that the Holocene marine transgression extensively eroded and "planed off" terrestrial landforms as they progressively were drowned by the rising water. However, evidence from high-resolution seismic-profiling systems and coring have indicated that some recognizable landform features and terrestrial strata exist offshore and, therefore, have at least partially survived the transgression. These landforms have been modified by marine processes such as ice gouging, wave erosion, current and strudel scouring, and sedimentation.

III.A.1.d(2) Offshore Geology

III.A.1.d(2)(a Offshore Physiography

The Beaufort Shelf is relatively narrow, ranging from about 57 miles (90 kilometers) in the west to 30 miles (50 kilometers) in the east. Barnes and Reimnitz (1974) divided the shelf into three zones based on surficial sediment textures and the sedimentary environment: the inner shelf, from the coast to the 20-meter (65-foot) isobath; the central shelf, from the 20-meter (65-foot) isobath to the shelf break (the 60-meter [190-foot] isobath); and the shelf break, between the 60-meter (190-foot) and 200-meter (650-foot) isobaths (Figure III.A-6).

III.A.1.d(2)(b) Barrier Islands

Barrier islands are found along most of the Beaufort coast (Figure III.A-7). Some of these are dynamic constructional islands, and some are remnants of the Arctic Coastal Plain. Active constructional islands migrate westward and landward. Hopkins and Hartz (1978a) determined migration rates of 19-30 meters (62-98 feet) per year westward and 3-7 meters (10-23 feet) per year landward. The islands generally are becoming narrower and are breaking up into smaller segments as they migrate. Between 1950 and 1978, Reindeer Island split in two. Cross, Argo, and Narwhal islands also have broken up in the recent past, and channels between the island fragments appear to be deepening (Reimnitz et al., 1979). The barrier islands of the McClure Island group (Figure III.A-8) gradually are moving to the south and west, as suggested in a comparison of ocean charts from 1952 and 1990 (see USDOI, MMS, Alaska OCS Region, 2002a:Figure VI.C-3). Sediment derived from these islands probably is being redeposited as shoals and sand ridges. Dinkum sands, a shallow shoal between Narwhal and Cross islands (Figure III.A-8), stood 1 meter above mean high water in 1950 but, because of erosion, disappeared beneath the water in 1975 (Reimnitz, Ross, and Barnes, 1979). Ice push, storm surges, and longshore currents during the open-water season are the major causes of the migration and breakup of barrier islands. Sediment grain size and lithology indicate that most constructional islands are isolated from their original sediment source (Hopkins and Hartz, 1978a).

III.A.1.d(2)(c Stratigraphy

III.A.1.d(2)(c)1) Pleistocene Deposits

Offshore, Pleistocene strata generally are a continuation of those under the Arctic Coastal Plain. They underlie the Beaufort shelf or are exposed at the seafloor where Holocene sediments are absent. Pleistocene strata were deposited during fluctuating sea levels and are collectively called the Gubik Formation (Black, 1964). When sea level dropped, streams and rivers deposited sediments as alluvial layers and deltas that together formed a seaward-thinning wedge. When sea level rose, silts and clays, with some boulders carried by floating pack ice, were deposited to form a landward-thinning wedge. The part of the Gubik Formation that contains these "erratic" glacially transported boulders is called the Flaxman

Island member, which was deposited in a shallow marine environment approximately 70,000 years ago (Dinter, 1985).

Pleistocene strata on the shelf generally thicken seaward away from the Brooks Range. Based on shallow seismic data (Dinter, Carter, and Brigham-Grette, 1990), the thickness of the Gubik Formation is hundreds to several hundreds of feet (hundreds of meters). The base of the Gubik Formation offshore is not well defined on seismic data, because it is similar to the marine and deltaic strata of the underlying Tertiary Brookian sequence and displays similar acoustic-reflection properties. Some researchers have recognized two units within the Pleistocene strata, an upper unit, and a lower unit. The lower unit correlates with strata encountered in shallow cores that consist mainly of terrestrial beach, lagoon, delta, and alluvial deposits composed of sands, sandy gravels, and silty sands (Duane Miller & Assocs., 1997, 1998). This unit is predominantly a nonmarine member of the Gubik Formation. The upper Pleistocene unit generally consists of marine silts, clays, sands, and isolated organic-rich silts and peat. It contains occasional erratic boulders and cobbles and, in Foggy Island and Camden bays, boulders and cobbles crop out at the seafloor, as illustrated in Figures III.A-10a, 10b, and 11 (Thurston, Choromanski, and Crandall, 1999).

Their similarity to onshore deposits and evidence from core-hole data (Dinter, Carter, and Brigham-Grette, 1990) suggest that the seafloor exposures of boulders and cobbles are likely outcrops of the marine Flaxman Member of the Gubik Formation. Erosion of the Flaxman sediments left a lag made of gravel, cobbles, and boulders and, where concentrated on the seafloor, it is called the Boulder Patch (Figure III.A-9). These boulders support an abundant fauna (Reimnitz and Ross, 1979; Dunton, Reimnitz, and Schonberg, 1982).

III.A.1.d(2)(c)2) Holocene (Recent)

Holocene sediments generally are thin across the shallow Beaufort shelf. Geotechnical borings (Bruggers and England, 1979; Duane Miller & Assocs., 1997, 1998; Harding Lawson Assocs., 1981b) show that Holocene sediments are mainly soft, reworked marine silts, clays, and fine-grained sands.

The sources of these deposits are stream sediment, eroded coastal sediments, and fine-grained marine sediments carried by coastal currents. Seasonal storms, offshore currents, and ice scour rework and redistribute fine-grained sediments. This reworked Holocene veneer covers older Holocene and Pleistocene features such as drowned lagoons, stream channels, and more recent features like ice gouges and strudel-scoured depressions. Borings in older Holocene and Pleistocene strata have recovered medium-stiff to stiff silts, sands with local organic-rich silts and stiff clays, and peat (Duane Miller & Assocs., 1997, 1998).

The distribution of modern sediments on the Beaufort shelf is influenced by the original distribution of Pleistocene sediments on the emergent coastal plain, their modification by the Holocene marine transgression and associated changes in depositional environments, stream-sediment input, and the environmental and oceanographic conditions on the modern Beaufort shelf. In the present sedimentary regime, the intensity of ice gouging, wave and current activity, and the composition of sediment delivered from rivers and from coastal bluffs are the most important factors affecting sediment composition and texture.

In general, surface sediments east of Oliktok Point contain a greater coarse-grained fraction than those to the west. Most of this sediment is derived from coastal bluffs and reflects the character of sediments on the adjacent coastal plain. In the western Arctic Slope, the coastal plain is broad (the Brooks Range sediment source is more than 90 miles [150 kilometers] south of the present coast), and rivers crossing the coastal plain are characteristically slow and meandering. The coastal plain sediments are predominantly fine-grained fluvial and thaw-lake deposits. East of Oliktok Point, the coastal plain is narrower and higher in average gradient. There, coastal plain sediments are composed of coarse sediment derived from coalescing alluvial fans and braided river systems.

The inner shelf is characterized by moderately sorted to well-sorted silts and fine sand, which are actively transported by waves and currents during the open-water season. This area lies in the fast-ice zone and is relatively unaffected by ice gouging. In places, sedimentary bedforms are more common than ice gouges. These sediments are derived primarily from coastal erosion and river effluents. The central-shelf sediments are predominantly gravelly muds. These sediments are highly disrupted by ice gouging and few sedimentary structures are preserved. The coarse clasts in the muds are angular and frequently striated, indicating that they were deposited as ice-rafted debris. The shelf-break facies is characterized by a 2- to 8-inch (5- to 20-centimeter) thick unit of muddy gravel overlying a clayey silt unit. The surface unit generally becomes coarser grained to the east, where it contains abundant fauna and is bioturbated. In the lower clayey silt unit, bioturbation is uncommon. Water depths here prevent most modern ice gouging, because most ice keels do not reach the seafloor.

Superimposed on these general sediment zones are numerous areas of coarse-grained surface sediments on the Beaufort shelf. These generally are thin and discontinuous. However, large bodies of coarse sediment are located on the shelf as constructional islands (discussed under III.A.1.d(2)(b) Barrier Islands) and submerged shoals. The most prominent of the shoals is the Reindeer-Cross Islands ridge (Figure III.A-8), which extends several kilometers northwest of Reindeer Island (Rodeick, 1979). In Harrison Bay, two low, sandy shoals of coalescing sand waves occur. These shoals each may contain 100,000 cubic meters of sand (Briggs, 1983). High-resolution seismic profiles indicate that at least some of these shoals and sand waves are migrating over ice-gouged sediments.

In outer Harrison Bay, there is a series of shoals in 50-65 feet (15-20 meters) of water. These shoals probably are related to physical processes within the stamukhi zone; they are located on the shoreward edge of the stamukhi zone (Reimnitz and Maurer, 1978a). These shoals include Weller Bank in outer Harrison Bay and Stamukhi Shoal north of the Jones Islands. The surface of these features is covered by coarse sand and gravel. However, sandy mud found in ripple troughs on Weller Bank (Barnes and Reiss, 1981) indicates that finer material may underlie the surface of these features.

The distribution of clay on the Beaufort Shelf suggests that they are detrital and not formed in place by chemical alteration (Naidu and Mowatt, 1983). There is no obvious modern source for smectite clay on the outer shelf, and these may be relict Pleistocene or older sediments. This implies that modern sedimentation rates are low on these parts of the shelf.

Holocene sediments on the outer shelf of the Beaufort Sea are not well mapped, and their thickness is unknown. Uniboom lines, from Dinter (1982) indicate that the transparent layer he interprets as the Holocene sequence is wedge shaped, thickening to more than 150 feet (45 meters) at the shelf edge off Camden Bay. Reimnitz et al. (1982) collected grab samples from the outer shelf in the same area and reported the occurrence of relict surficial gravels. They suggest that much of what Dinter (1982) identified as Holocene in age actually is Pleistocene. Knowing the age of sediments on the outer shelf and upper slope is useful, because they are involved in massive slumps and would help determine the most recent age of slump activity. The Holocene sequence is thin or absent over the anticlines north of Barter Island, where historic seismicity and shallow faults exist.

III.A.1.d(2)(d) Seafloor Features

III.A.1.d(2)(d)1) Permafrost

The Beaufort shelf was exposed to the Arctic atmosphere during several Pleistocene lowstands of sea level (see USDOI, MMS, Alaska OCS Region, 2002a:Table VI.C-2). During this time, bonded permafrost formed to depths of several hundred meters beneath the exposed shelf (Hunter and Hobson, 1974). During subsequent highstands of sea level, the bonded permafrost partially melted both from above by thermal heating from warm seawater and by saline advection from the seawater into the underlying sediment, and from below by geothermal heating. Coreholes have shown that seafloor sediments are at or below the freezing point, although it is not bonded permafrost (Miller, 1996, 1997, 1998, 1999; Harding Lawson Assocs., 1981a, 1985, 1988; Woodward-Clyde Consultants, 1981, 1982; EBA Engineering Inc., 1991, 1996; Pelagos Corp., 1990a,b; Dames and Moore, 1983a,b, 1985a,b, 1993; Fairweather E&P Services, 1997a,b; ENSR Consulting and Engineering, 1990; Northern Technical Services, 1985).

III.A.1.d(2)(d)2) Ice Gouges

Ice gouging is intense and almost pervasive on the shallow Beaufort Sea shelf in water depths between 60 and 165 feet (18 and 50 meters) deep (Barnes and Rearic, 1985, 1986; Barnes, Rearic, and Reimnitz, 1985; Barnes, McDowell, and Reimnitz, 1977; Wolf, Reimnitz, and Barnes, 1985). Ice gouging is one of the most important agents of sediment reworking on arctic continental shelves. It is particularly important at midshelf and innershelf water depths. On the midshelf, ice ridges with deep keels intensely scour the seafloor to depths of several meters. Reimnitz and Barnes (1974) found gouges as deep as 18 feet (5.5 meters), with ridges 9 feet (2.7 meters) high (total relief of 27 feet [8.2 meters]), in 128 feet (39 meters) of water off Smith Bay. For planning purposes, ice gouges with 33 feet (10 meters) of relief may be expected. The maximum incision depth of ice gouges tends to increase with increasing water depth down to a depth of about 150 feet (45 meters) (Barnes, 1981).

Although ice gouges are found across the entire shelf, they are concentrated in the stamukhi zone, generally between the 60- and 100-foot (18- and 30-meter) isobaths (Figures III.A-12 and III.A-13). Ice gouging is most intense on the seaward slopes of shoals and islands near the stamukhi zone. Little or no ice gouging occurs on their shoreward side (Reimnitz et al., 1982). Off Prudhoe and Foggy Island bays, the inner boundary of high-intensity ice gouging is controlled by the island chains, generally 9-13 miles (15-20 kilometers) from the coast. In Harrison Bay where there are no barrier islands, two zones of high-intensity ice gouging occur: one near the 33-foot (10-meter) isobath and the other in 65 feet (20 meters) of water seaward of Weller Bank (Reimnitz, Toimil, and Barnes, 1978). These zones correspond to areas of abundant ice-ridge formation.

Inshore of the stamukhi zone (usually in water depths less than 60 feet [18 meters]), ice gouging is much less severe, with gouge depths generally less than 1 meter (see USDOI, MMS, Alaska OCS Region, 2002a:Figure VI.C-9). According to Barnes, McDowell, and Reimnitz (1978), an average of 1% or 2% of the seafloor per year is gouged in this area, and current-related hydraulic bedforms dominate over ice gouges (Barnes and Reimnitz, 1974). Any ice gouges that formed would be buried by sand waves or sediment sheets.

Ice gouging is sparse in areas that lie beneath shorefast floating ice such as parts of Foggy Island Bay (Watson Company, 1998a,b, 1999; Arctic Geoscience, Inc., 1997; Blanchet et al., 2000; Coastal Frontiers Corporation, 1998), and Camden Bay (Fairweather E&P Services, 1997; Thurston, Choromanski, and Crandall, 1999). Modern ice gouging in areas of shorefast floating ice is confined to discontinuous, sparse, narrow, and shallow features (Figure III.A-14 and USDOI, MMS, Alaska OCS Region, 2002a:Figure VI.C-6). In the shallow water of Camden Bay (20-30 feet [6-8 meters]), ice gouges generally are 6-12 feet (2-4 meters) wide and 3 feet (1 meter) deep. Foggy Island and Camden bays are protected from the large ice masses responsible for major ice gouging in other parts of the Beaufort Sea by the outlying barrier islands and by floating shorefast ice, which blocks most drift ice from entering the bay. The protection of the seafloor from gouging is what allows biological habitats to form in the Boulder Patch.

III.A.1.d(2)(d)3) Ice Push

On islands and coastal regions throughout the Beaufort Sea, ice-push and ice-override events transport and erode significant amounts of sediment. Ice push occurs when ice blocks, forced onshore by strong winds or currents, push sediment into ridges farther inland. On the outer barrier islands such as Narwhal and Cross islands, ice-push ridges up to 8 feet (2.5 meters) high and extending 330 feet (100 meters) inshore from the beach have been identified (Hopkins and Hartz, 1978a). Ice-push rubble has been found 65 feet (20 meters) inland over most of the arctic coast (Kovacs, 1984). At the Northstar pipeline shore crossing, ice rideup could extend as far as 32 feet (10 meters) inland (U.S. Army Corps of Engineers, 1999). Boulders in excess of 5 feet (1.5 meters) in diameter are found on some of these rubble piles. There are historic accounts of ice-push events, which have damaged manmade structures along the Beaufort coast. In January 1984, ice pileup overtopped the Kadluk, a 26-foot (8-meter) high caisson-retained drilling island located in Mackenzie Bay in the Canadian Beaufort Sea (Kovacs, 1984).

III.A.1.d(2)(d)4) Currents and Current Scour

Marine currents across the inner shelf of the Beaufort Sea are wind driven and strongly influenced by the presence or absence of ice. These coast-parallel currents transport sediment along barrier islands and coastal promontories. However, because of the short open-water season, the annual rate of longshore sediment transport is relatively low. Inner-shelf currents generally flow to the west in response to the prevailing northeast wind, although current reversals are common close to shore and during storms. On the open shelf, currents average 0.2 knot (between 7 and 10 centimeters per second) (Matthews, 1981). During storms, east-flowing currents with peak velocities of 2 knots (95 centimeters per second) have been measured, although typical storm-current velocities are an order of magnitude lower (Kozo, 1981). During the winter, under-ice currents generally are weak, less than 0.1 knot (2 centimeters per second), although some have been measured up to 0.5 knot (25 centimeters per second) in restricted passages around grounded ice blocks (Matthews, 1981). Geostrophic currents with velocities of up to 1 knot (50 centimeters per second) occur on the outer shelf, flowing parallel to the shelf-slope break in both easterly and westerly directions. The tidal range on the Beaufort shelf is small, 0.5-1 foot (15-30 centimeters) and, except in confined passages, tidal currents exert only a minor influence on the sedimentary regime (Matthews, 1981). However, they can be important scouring agents where waterflow on the shelf is restricted by bottomfast ice (Reimnitz and Kempema, 1982b) and by narrow passages between barrier islands and shoals.

III.A.1.d(2)(d)5) Strudel Scour

During spring runoff, landfast sea ice is inundated by river floodwaters. Extensive areas of the fast ice near major river mouths are covered as far as 3-4 miles (5-6.5 kilometers) from shore to depths of up to 5 feet (1.5 meters). When the floodwater reaches holes or small cracks in the ice, it rushes through with enough force to scour the bottom to depths of several meters by the process of strudel scour (Reimnitz, Rodeick, and Wolf, 1974). The resulting features are called strudel scours. Some of these strudel scours near major river mouths may be as deeps as 20 feet (6 meters) and as wide as 65 feet (20 meters) (Reimnitz, Rodeick, and Wolf, 1974). Generally, the craters are a few feet up to 10 feet deep (1-3 meters) and tens of feet across (Blanchet et al., 2000). Sheltered coastal areas and bays off major rivers, such as the Colville, Sagavanirktok, and Canning, are particularly susceptible to strudel scouring (Coastal Frontiers Corporation, 1999, 1998). In these areas, deltas can be totally reworked by strudel scouring in several thousand years (Reimnitz and Kempema, 1982a) (see USDOI, MMS, Alaska OCS Region, 2002a:Figure VI.C-12).

III.A.1.d(2)(e) Subsurface Features

III.A.1.d(2)(e)1) Buried Channels

Buried, relict stream channels are evident throughout most of the inner and middle Beaufort shelf in areas offshore of modern river deltas (Figure III.A-10a). In Foggy Island Bay near the proposed Liberty Island, channels underlie the Holocene marine unit. These channels are cut into the Pleistocene unit and exhibit infill and overbank features (see USDOI, MMS, Alaska OCS Region, 2002a:Figure VI.C-10). Most of these channels trend generally north and are extensions of the modern rivers such as the Canning or Sagavanirktok onto the paleo-Arctic Coastal Plain.

III.A.1.d(2)(e)2) Lagoons

Possible lagoon features are present in the shallow part of Foggy Island Bay and are expressed on seismic profiles as filled-in depressions. At the base of these depressions is a discontinuous, high-amplitude or “brightened” reflector, probably representing a peat layer (USDOI, MMS, Alaska OCS Region, 2002a:Figure VI.C-1). Cores in the area (Duane Miller & Assocs., 1997, 1998) suggest such deposits are present (Dinter, Carter, and Brigham-Grette, 1990). Other areas in the shallow Beaufort shelf also may contain such features.

III.A.1.d(2)e)3) Permafrost

The occurrence and extent of permafrost offshore still is not well known. Bonded permafrost offshore appears to be related to the presence of overconsolidated, low-permeability silts and clays of the Flaxman Member of the Gubik Formation. These silts and clays form a barrier to the infusion of saltwater that would lower the thaw point and cause ice to melt (Duane Miller & Assocs., 1997).

Numerous refraction, borehole, and conductivity surveys indicate that permafrost is widespread beneath the Beaufort inner shelf. Seismic-refraction surveys were performed in Harrison Bay by Rogers and Morack (1981) and Neave and Sellmann (1983), in Simpson Lagoon by Neave and Sellmann (1983), on the barrier islands by Rogers and Morack (1981), and on the Canadian Beaufort shelf by Morack, McAulay, and Hunter (1983). Further data have been obtained from boreholes (Harding Lawson Assocs., 1979) and thermal probes in the BF-79 sale area (Rogers and Morack, 1981; Hopkins and Hartz, 1978b) and offshore of Cape Simpson (Harrison and Osterkamp, 1981). On the Canadian Beaufort, permafrost has been cored as far offshore as 32 kilometers north of Cape Bathurst (Hunter and Hobson, 1974). Seismic-refraction work by Sellmann, Neave, and Chamberlain (1981) indicates that on the Alaskan Beaufort shelf, a high-velocity layer interpreted to represent permafrost is present at least 15 kilometers north of Reindeer Island and at least 25 kilometers offshore of Harrison Bay.

The depth to the surface of subsea permafrost is highly variable, due to different degrees of ice bonding before it was inundated with warm water of the Holocene marine transgression and the amount and distribution of subsequent thawing probably due to the introduction of saline groundwater. Therefore, it is melting from above and below. In Stefansson Sound, U.S. Geological Survey boreholes (Harding Lawson Assocs., 1979) commonly encountered permafrost at depths shallower than 50 feet (15 meters). The depth to the surface of bonded permafrost varies greatly from less than 30 feet (9 meters) to greater than 98 feet (30 meters) over a distance of less than 7.5 miles (12 kilometers) (Harding Lawson Assocs., 1979). Some of the boreholes encountered a transition zone of partially bonded sediments between the unfrozen surface sediments and deeper, well-bonded sediments (Harrison and Osterkamp, 1981). This transition zone makes it difficult to accurately interpret the depth to the permafrost surface from both borehole logs and seismic-refraction data. Frozen sediment encountered in boreholes and interpreted to be well-bonded permafrost actually may be lenses of ice-bonded material in the transition zone. Similarly, high-velocity refractors may represent physical changes in the permafrost layer and may lie below the permafrost surface in the transition zone. As a result, there are differing interpretations of the depth to ice-bonded material between the U.S. Geological Survey boreholes (Harding Lawson Assocs., 1979) and the seismic refraction data of Rogers and Morack (1981).

Hopkins and Hartz (1978a) estimate that it takes only 40-50 years for well-bonded permafrost to form in a subaerial arctic environment. Permafrost, therefore, is expected to be present in the core of some barrier islands, which migrate across the seafloor. On Reindeer Island, the Humble Oil C-1 well encountered two layers of permafrost at depths of 0-62 feet (0-18.9 meters) and 298-420 feet (91-128 meters) (Sellmann and Chamberlain, 1979). The deeper layer probably is relict Pleistocene permafrost, while the shallow layer may have formed under modern arctic conditions since the island migrated to its present site.

The thickness of permafrost on the Beaufort shelf cannot be accurately determined from seismic-refraction data or shallow boreholes. However, the thickness of the permafrost layer beneath the coastal plain has been measured from numerous onshore wells in arctic Alaska and Canada. Onshore wells near Harrison Bay indicate that the permafrost layer thins to the west. East of Oliktok Point it is 1,640 feet (500 meters) thick, whereas west of the Colville River it is 984-1,312 feet (300-400 meters) thick (Osterkamp and Payne, 1981).

III.A.1.d(2)(e)4) Natural Gas Hydrates

Natural gas hydrates (solids composed of light gases caged in the interstices of an expanded ice-crystal lattice) commonly occur in deepwater areas of continental margins under low-temperature, high-pressure conditions (Macleod, 1982). On the Arctic shelf, gas hydrates may form at shallow depths associated with permafrost (Kvenvolden and McMenamin, 1980). In the Alaskan Arctic, gas hydrates are known to occur at shallow depths onshore at Prudhoe Bay (Kvenvolden and McMenamin, 1980), and hydrates may occur under similar conditions beneath the Beaufort inner shelf in areas underlain by permafrost (Sellmann, Neave, and Chamberlain, 1981; Collett, Barnett, and Beeman, 1994). Beneath the Beaufort continental slope, a gas-hydrate horizon is identified where water depths exceed 984 feet (300 meters) (Grantz et al., 1982; Collett, Barnett, and Beeman, 1994).

III.A.1.d(2)(f) Faulting and Seismicity

Several types of shallow faults are identified on the Beaufort shelf: high-angle, basement-involved faults that have both normal and strike-slip components (mapped principally along the Barrow Arch in Harrison Bay); listric growth faults (mapped seaward of the Hinge Line); reverse faults in outer Camden Bay and offshore of the Arctic National Wildlife Refuge; and down-to-the-north gravity faults (mapped along the shelf-slope break) (Grantz et al., 1982). Locally, two or more types may occur in close proximity.

High-angle faults occur along the Barrow Arch and are genetically related to basement tectonics of the Arctic Platform. In Harrison Bay, they offset Tertiary and older units (Craig and Thrasher, 1982). There is little evidence of Quaternary movement and no recent seismicity associated with these faults. However, they may act as conduits for gas migration, because "bright-spot" anomalies are commonly identified adjacent to the fault traces (Craig and Thrasher, 1982).

Shallow faults seaward of the Hinge Line include upper extensions of detached listric growth faults that have roots deep in the Brookian section, some of which may have been reactivated in late Cenozoic time. The distribution of these growth faults is known only partially because of a lack of high-resolution seismic coverage on the outer Beaufort shelf, especially in the west. These faults are mapped in greatest detail in the Camden Bay area where the Hinge Line approaches the Beaufort coast. Shallow faults also have been mapped beneath the outer shelf west of Cape Halkett and are reported to show 10-30 feet (3-10 meters) of Quaternary offset (Grantz, Dinter, and Biswas, 1983). In the Camden Bay area, near-surface faults have hundreds of feet (several tens of meters) of Quaternary offset (Grantz, Dinter, and Biswas, 1983) and, in contrast to the rest of the Beaufort shelf, Camden Bay is seismically active. Camden Bay is located at the northern end of a north-northeast-trending seismic zone that extends north from east central Alaska (Biswas and Gedney, 1979). The largest earthquake recorded in northeast Alaska was a magnitude 5.3 quake located 18 miles (30 kilometers) north of Barter Island (Biswas and Gedney, 1979). These events cluster along the axis of the Camden anticline. The faults in this area probably are older Hinge Line-related structures that were reactivated in late Tertiary and Quaternary time by the uplift of the Camden anticline (Craig, Sherwood, and Johnson, 1985). Seafloor expressions of active faults in Camden Bay mapped in the Warthog high-resolution survey area reach 10 feet (3 meters) (Thurston, Choromanski, and Crandall, 1999). Grantz and Dinter (1980) mapped fault scarps along two fault segments in Camden Bay, where they observed 20 feet (6 meters) of seafloor displacement. The evidence of seafloor scarps in this area is equivocal, however, because scarp heights are of the same magnitude as ice-gouge relief. In addition, the ice-gouging process should quickly smooth scarps formed on the seafloor. Therefore, active near-surface faults may be much more numerous in Camden Bay where ice gouging occurs than indicated by the number of seafloor scarps previously reported. Faults on the outer Beaufort shelf and upper slope are gravity faults related to large rotational slump blocks (Grantz and Dinter, 1980). On the eastern Alaskan Beaufort shelf, these slumps bound the seaward edge of the Beaufort Ramp. Shoreward of the Ramp, faults have surface offsets that usually range from 50-65 feet (15-20 meters) and, at one site, possibly as high as 230 feet (70 meters) (Grantz et al., 1982). The Beaufort Ramp itself may be a gigantic slump block, which is bounded by these gravity faults. The age of the shelf-edge faults is uncertain. If Grantz et al. (1982b) were correct in assuming that sediments on the outer shelf are Holocene in age, these faults have been active in Recent geologic time. If the surface sediments on the outer shelf are relict Pleistocene deposits, as suggested by Reimnitz et al. (1982), then these large gravity faults may have been quiescent throughout Holocene time (12,000 years Before Present to present). These faults pose an extreme hazard to bottomfounded structures on the outer Beaufort shelf and slope, because they could result in large downslope displacements. Even though there has been no historic seismicity associated with this type of fault on the Beaufort shelf, they may be moving by slow, aseismic creep. Large-scale gravity slumping of blocks on the outer shelf could be triggered by shallow-focus earthquakes centered in Camden Bay or in the Brooks Range, they also may be spontaneous or triggered by tidal forces, storm surges, or sediment loading.

III.A.1.d(2)(f)1) Sediment Slides

A chaotic sediment-slide terrane occurs along the length of the Beaufort outer shelf and upper slope seaward of the 164- to 197-foot (50- to 60-meter) isobath. Grantz et al. (1982b) have mapped several distinct landslide types, including large bedding-plane slides and block glides. The bedding-plane slides are most extensive on the Beaufort Ramp between 148° W. longitude and the Mackenzie Sea Valley (Grantz and Eittreim, 1979). These slides are 6-27 miles (10-43 kilometers) long and 230-750 feet (70-230 meters) thick. Pull-apart grabens and scarps are common on the landward margin of the slide terrane. Horizontal displacements of 656-7,544 feet (200-2,300 meters) are estimated to have occurred along slip planes that dip only 0.5-1.5 degrees (Grantz and Eittreim, 1979). The thinner slides probably are Holocene in age, although the sediments involved in sliding have not been directly dated.

Block glides are prominent between 155° and 158° W. longitude along the outermost shelf in water depths greater than 70 meters (Grantz and Eittreim, 1979). Multiple open cracks 26-56 feet (8-17 meters) deep, spaced 330-1,600 feet (100-500 meters) apart, occur throughout this slump terrane. Seismic-reflection data indicate that these blocks slide along failure surfaces, which are subparallel to the underlying bedding. The geomorphic character of the blocks indicates that they presently may be active.

Massive slumps occur on the Beaufort continental slope either spontaneously or by wave loading or earthquakes. As discussed previously, these features are bounded by gravity faults with total displacements estimated to be as great as 3,000 feet (1,000 meters) (Grantz et al., 1982).

III.A.1.d(2)(f)2) Overpressured Sediments

In the planning area, abnormally high pore pressures probably will be found in areas where Cenozoic strata are uncommonly thick, such as in the Kaktovik, Camden, and Nuwuk basins. Onshore in the Camden Basin, abnormal pressures are observed in both Tertiary and Cretaceous formations, where burial depths of Tertiary strata exceed 9,840 feet (3,000 meters). Abnormal pore pressures have not been encountered in onshore wells elsewhere on the Arctic Platform. In the Point Thomson area, pore-pressure gradients as high as 0.8 pounds per square inch per foot have been measured in sediments at burial depths of 13,120 feet (4,000 meters) (a pore-pressure gradient of 0.433 pounds per square inch per foot is considered normal). Excess pore pressures also are widespread in Cenozoic strata of the Mackenzie Delta area in the Canadian Beaufort (Hawkings et al., 1976).

In the Kaktovik Basin, the recently exhumed sedimentary rocks, which now lie near the axis of the Camden anticline, may preserve high pore pressures developed during a prior period of deep burial. The degree to which these sediments are overpressured would depend on the amount these sediments have been uplifted since folding began. Along the continental slope east of 146° W. longitude, a series of shale diapirs disrupts Tertiary sediments. These features have been attributed to liquefaction of the shale in response to an overpressured condition resulting from incomplete dewatering.

III.A.1.d(2)(f)3) Shallow Gas

Shallow gas is common in marine sediments. However, when gas is concentrated and under pressure by being trapped at shallow subsurface depths (about 300-3,000 feet [100-1,000 meters]), it poses a drilling hazard. Shallow gas is likely to be found on the Beaufort shelf, although no shallow gas has been detected in any offshore Beaufort Sea exploration wells due to avoidance of these anomalies, and because gas is not sampled at these shallow depths in an exploration well. Free-flowing gas was encountered directly in one U.S. Geological Survey borehole in Stefansson Sound (Harding Lawson Assocs., 1979). Also, numerous and various anomalies associated with gas or gas-charged sediments have been indicated on many seismic profiles throughout the area as isolated pockets possibly beneath permafrost, association with faulted strata, and as concentrations in Pleistocene coastal plain sediments and peat deposits (see USDOI, MMS, Alaska OCS Region, 2002a:Figure VI.C-11). Published information on possible shallow gas, inferred from seismic data, include data from Stefansson Sound (Boucher, Reimnitz, and Kempema, 1980), in Harrison Bay (Craig and Thrasher, 1982; Sellmann, Neave, and Chamberlain, 1981), and on extensive areas of the outer shelf and upper slope (Grantz et al., 1982). In addition, many industry surveys collected for site clearance have indicated the possible presence of shallow gas (Thurston, Choromanski, and Crandall, 1999). Figure III.A-15 shows areas of acoustic anomalies in site surveys that probably are related to shallow gas.

Elsewhere beneath the inner shelf, the presence of gas is indicated by acoustically turbid zones and high-frequency signal attenuation on high-resolution seismic records. In Harrison Bay, Craig and Thrasher (1982) mapped shallow gas adjacent to near-surface faults on the basis of acoustic anomalies with bright spots (amplitude increase), reflector pulldown, and high-frequency signal attenuation.

On the outer shelf, a continuous band of acoustically turbid sediment, which Grantz et al. (1982b) interpret to be shallow gas, extends from the Canadian border west to at least 158° W. longitude. There also is a large area inferred to have a high concentration of shallow gas in the southwestern corner of the planning area north of Wainwright (Grantz et al., 1982a).

III.A.1.d(2)(f)4) Other Buried Features

Possible ice/sand-wedge, strudel-scour, ice-gouge, and small stream-cut features are visible on some records (see USDOI, MMS, Alaska OCS Region, 2002a:Figures VI.C-11 and VI.C-12), usually more toward shore. These relict features are covered over or filled in by Holocene deposits and they usually are no more than 3-6 feet (1-2 meters) below the seafloor.

III.A.2. Climate and Meteorology

Meteorological conditions primarily control the characteristics of the Beaufort Sea. Air temperature, precipitation, and wind speed and direction are the most important. Air temperature controls when river ice breaks up and how much heat transfers between the atmosphere and the water. Precipitation controls the timing and amount of freshwater input. Winds control the mixing and distribution of the water's physical properties by moving the water on the surface.

The onshore area next to the Beaufort multiple-sale area is within the Arctic Coastal Zone (Zhang, Osterkamp, and Stamnes, 1996). The Arctic Coastal Zone has cool summers and relatively warm winters, because it is near the ocean. Precipitation is lowest in this region, and more than 50% falls as snow. Table III.A-1 summarizes the climatic conditions for the Arctic Coastal Zone.

III.A.2.a. Air Temperature

Monthly average air temperatures for the Beaufort multiple-sale area rise above freezing only in June, July, and August. Even during these months, air temperature on any day may vary from near 0-20° Celsius. July typically is the warmest, with an average air temperature onshore of about 7-9° Celsius and offshore of 4-6° Celsius. December through March usually are the coldest months. Figures III.A-16, III.A-17, and III.A-18 show the seasonal variation of the mean monthly air-temperature maximums and minimums, over the period of record from 1949-1996 for Barter Island, Prudhoe Bay, and Barrow Alaska. Air temperatures generally remain below freezing for 9 months of the year. Average monthly temperatures range from -20 to +40° Fahrenheit at Barrow.

III.A.2.b. Precipitation

Figures III.A-16, III.A-17, and III.A-18 show the seasonal variation of the mean precipitation, snowfall, and snow depth averaged over the period of record from 1949-1996 for Barter Island, Prudhoe Bay, and Barrow. Summer rainfall is infrequent and averages less than 30 millimeters per month (Hummer, 1990, 1991). Occasional late-summer rainstorms can increase the amount of seasonal and annual rainfall. Although rainfall usually is light during the short summers, heavier rainstorms occasionally occur, most commonly in the foothills. Summer precipitation, generally greatest in July and August, is 114 millimeters at Sagwon (U.S. Department of Agriculture, 1996). Snow cover on the North Slope begins from late September to early October and disappears from late May through the middle of June (Zhang, 1993; Zhang, Stamnes, and Bowling, 1996). Warren Matumeak, a Barrow resident, reported that during the last part of September or October the weather begins to change; typically, snow is falling, and fog and ice form during this period (USDOI, MMS, 1990b:41). The timing of snowmelt varies mainly with changes in the incoming longwave radiation (Zhang, Bowling, and Stamnes, 1997). The average snow depth from January through April is 13.6, 3.7, and 10.2 inches, respectively, for Barter Island, Prudhoe Bay, and Barrow Alaska.

III.A.2.c. Winds

Wind speed and direction control coastal oceanographic conditions. Winds affect ice distribution, current speed and direction, vertical and horizontal mixing of watermasses, and wave action. The dominant wind direction in the open-water season is easterly to northeasterly. Easterly winds typically are more persistent in the early season (June and July). As the open-water season progresses, westerly winds are more frequent. Average wind speeds during the open-water season are near 5 meters per second in Stefansson

Sound. Wind speeds above 8 meters per second fully mix the vertical column of water in Stefansson Sound. Figure III.A-19 shows wind roses for Badami, Endicott, Milne Point, and Northstar for the year 2001.

Meteorological data from Tern Island in Foggy Island Bay during February through May show wind speeds ranging from 0-14 meters per second, with an average of 4-6 meters per second (Table III.A-2). The dominant wind direction during the ice-covered season is westerly.

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 states:

> 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, Alaska OCS Region, 2001b).

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 Alaska Eskimo Whaling Commission, 2001).

III.A.2.d. Storms

Lynch et al. (2001) show the Barrow high wind events from 1960-2000, concluding 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 and the storms in April, May, and June are part of a new pattern. In the Sale 124 Public Hearing in Kaktovik, Mr. Ningeok stated that:

> …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 the summer are indicators of an impending major storm (Nuiqsut Community Meeting, August 14, 1996 [USDOI, MMS, 1996b: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 (Barrow Whaling Captains Meetings, August 27 and 28, 1996 [USDOI, MMS, 1996c: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).

III.A.2.e. Changes in the Arctic

Over the entire Arctic Ocean, the annual trend in surface-air temperature shows a warming of about 1.0° Celsius 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 (Rigor, Colony, and Martin, 2000). During fall, the trends show a cooling of about 1.0° Celsius per decade over the Beaufort Sea and Alaska Sea (Rigor, Colony, and Martin, 2000). During spring a significant warming trend of 2° Celsius per decade can be seen over most of the Arctic. Summer shows no significant trend (Rigor, Colony, and Martin, 2000). Barrow has experienced a significant warming over the last 80 years, but this warming is not uniform for all seasons and is not uniform over the entire period from 1920-1980 (Lynch, et al. 2001).

For More Information on Meteorology: The EIS's for MMS Sales 124, 144, and 170; the Liberty Development and Production Plan; and the U.S. Army Corps of Engineers' Northstar Project discuss the regional meteorology of the Beaufort Sea (USDOI, MMS, 1990a, 1996a; 1998; USDOI, MMS, Alaska OCS Region, 2002a; U.S. Army Corps of Engineers, 1999). The Endicott Environmental Monitoring Reports from 1986 through 1990 discuss meteorology near Endicott and the surrounding area (Hummer, 1990, 1991; Cover, 1991; and Walter, Horgan, and Cover, 1991, 1992).

III.A.3. Oceanography

The Beaufort multiple-sale area lies within the Alaskan Beaufort Sea. The Alaskan Beaufort Sea extends from Point Barrow to the Canadian border. For this discussion, the Beaufort Sea is divided into two main areas: offshore, with water depths greater than 40 meters and nearshore, with water depths less than 40 meters.

III.A.3.a. Major Features and Water Depth

The Beaufort Sea multiple-sale area includes the continental shelf, slope, and rise of the Alaskan Beaufort Sea. Map 5 shows the major physiographic and bathymetric features within the sale area. Water depths within the sale area range from about 1 meter (approximately 3 feet) to more than 1,500 meters (4,921 feet). The major Beaufort Sea features are the barrier islands and shoals, the shelf, slope, rise, and abyssal plain. Shoals rise 5-10 meters (16-33 feet) above the surrounding seafloor and are found in water depths of 10-20 meters (33-65 feet). The barrier islands are low-lying features that move with time. These barrier islands are washed over in large storms. Islands in the Arctic exhibit characteristics of both the wave-dominated and mixed-energy types identified by Hayes (1976). Like typical wave-dominated barrier islands, most islands in the Arctic are narrow (less than 250 meters) and have low elevations (less than 2 meters). However, islands in the Arctic tend to be shorter (average less than 5 kilometers) than most wave-dominated islands (15-25 kilometers) (Stutz, Trembainis, and Pilkey, 1999). The shelf varies in width between Barrow and Canada. The major canyon is the Barrow Canyon just northeast of Barrow. The slope has water depths averaging from 60 (197 feet) to 1,500 meters (4,921 feet).

III.A.3.b. Offshore

The offshore is influenced primarily by the large-scale arctic circulation, which is driven by the large-scale atmospheric-pressure fields.

III.A.3.b(1) Circulation and Currents

Within the Beaufort multiple-sale area, the large-scale shelf and slope surface-water circulation is dominated by the Beaufort Gyre, which moves water to the west in a clockwise motion at a mean rate of about 5-10 centimeters per second (Map 5). Below the surface waters, on the slope, the Beaufort Undercurrent moves to the east with frequent reversals to the west (Coachman and Barnes, 1961, Aagaard et al., 1989). The Beaufort Undercurrent is part of a larger cyclonic circulation transporting Atlantic Water to the Canadian Basin. Long-term mean speeds of the undercurrent are about 5-10 centimeters per second, but daily mean values may be 10-times greater.

The Alaska Coastal Current flows northeastward along the Chukchi Sea coast at approximately 5 centimeters per second and drains into the Barrow Canyon (Johnson, 1989; Weingartner et al., 1998). Barrow Canyon mean currents range from 14-23 centimeters per second, with maximum current speeds of approximately 100 centimeters per second (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, 1989; Aagaard and Roach, 1990).

III.A.3.b(2) Temperature and Salinity

The subsurface water extends from near the surface to the bottom between the 40-to-50- and 2,500-meter isobaths and contains two watermasses from the Bering Sea (Mountain, 1974). The Alaska Coastal Water forms in the nearshore environments of the Bering and Chukchi seas from warm, low-salinity runoff and warmed Bering Sea Water. The Bering Sea Water is colder and more saline than the Alaska Coastal Water. Near Barrow, the Alaska Coastal Water has temperatures of 5-10° Celsius and salinities that generally are less than 31.5 parts per thousand; the Bering Sea Water temperatures are near 0° Celsius and have salinities of 32.2-33 parts per thousand (Lewbel and Gallaway, 1984). The Alaska Coastal Water mixes rapidly with the surface water in the Beaufort Sea and is not clearly identifiable east of Prudhoe Bay. The Bering Sea Water is traced as far east as Barter Island.

The data from conductivity, temperature, and density logs show a relatively constant salinity of approximately 33.1 parts per thousand along the Alaskan Beaufort Slope at about 120 meters east of 152° W. longitude (Okkonen and Stockwell, 2001). Temperatures range between -1.7° and -1.3° Celsius and generally are higher by about 0.1° Celsius west of 152° W. longitude than to the east (Okkonen and Stockwell, 2001). Pickart (2001) shows that this cold subsurface watermass is relatively stable seaward of the upper slope.

III.A.3.c. Nearshore

The nearshore is landward of the 40-meter water-depth line. This region is influenced primarily by the wind. Other influences include river discharge, ice melt, bathymetry, and how the coast is aligned.

III.A.3.c(1) General Seasonal Cycles

In the early summer (mid-June to mid-July), the ice melts, and rivers break up and overflow the frozen ocean. Open water 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 greater-than-50% ice cover, there is little mixing of the fresh- and marine-water layers by the wind (Colonell and Niedoroda, 1988; Envirosphere, 1988b; LaBelle et al., 1983).

By midsummer (mid-July to mid-August), 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, 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).

III.A.3.c(2) General Circulation

There are two distinct periods—open water and ice covered—for nearshore 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). Map 5 shows that the generalized nearshore circulation is variable and depends on the winds direction. 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. Thomas Napageak stated: "… they both work together, the current and the wind" (Napageak, as cited in Dames and Moore, 1996b:7). Other controls on circulation include river discharge, icemelt, bathymetry, and the configuration of the coastline. The water circulation below the mixed layer appears to be driven primarily by ocean circulation rather than the winds (Aagaard, Pease, and Salo, 1988).

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. 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, 1990). Vincent Nageak stated: "Foggy Island is always the place to go when strong winds start from the west because the water is shallow there. The current is always to the east" (Nageak, as cited in Shapiro and Metzner, 1979).

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.

The West Dock and Endicott causeways are manmade structures that act as barriers affecting the circulation and mixing of watermasses in the nearshore Beaufort Sea near Prudhoe Bay. Fechhelm et al. (2001) report that recent causeway breaches at West Dock mitigate differences in cross-causeway temperature and salinity observations during the open-water season. The breaches at the Endicott causeway had no observable effect.

In contrast to the open-water season, the landfast ice in the nearshore areas insulates the water from the effects of the winds. The circulation pattern is influenced by storms and brine drainage (Weingartner and Okkonen (2001).

III.A.3.c(3) Currents

During the open-water season, currents on the inner shelf range from zero to more than 68 centimeters per second during the open-water season (Woodward-Clyde Consultants, 1998). The highest speeds occur in the summer and fall (Weingartner and Okkonen, 2001). Between mid-October through June, current speeds seldom exceeded 10 centimeters per second. The currents are relatively weak, but there are events of several days' duration when current speeds averaged about 10 centimeters per second at all locations (Weingartner and Okkonen, 2001).

Archie Ahkiviana stated that the currents are very strong around Tern Island (Alaska Eskimo Whaling Commission, 2001). Mr. Tukle states: "With regards to Liberty, with the ocean currents that I've observed between Kaktovik, Barrow, and Nuiqsut, that Liberty Project that you guys are on is one of the strongest currents I ever seen on a slope between here and Barter Island." (Tukle, as cited in USDOI, MMS, Alaska OCS Region, 2001a). Mr. Tukle also states: "Right between Narwhal, that's north of this Liberty Project, right on the left side of Narwhal, that's the strongest current I ever seen between her and Kaktovik. And it's directly in between–almost in between Cross Island and Narwhal. It's every–it's there every single year" (Tukle, as cited in USDOI, MMS, Alaska OCS Region, 2001a).

III.A.3.c(4) Temperature and Salinity

The nearshore area exhibits a wide range of temperatures and salinities based on a generalized open-water pattern. The nearshore is made up of freshwater, marine water, and a mixture of both. The main factors determining the waters' 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 the 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° Celsius until June. Salinities are approximately 28-32 parts per thousand before the landfast ice develops. By January, salinities range from 24-35 parts per thousand (Weingartner and Okkonen, 2001).

III.A.3.c(5) Tides and Storm Surges

The semidiurnal tidal range is 6-10 centimeters in the Beaufort Sea (Matthews, 1980; Kowalik and Matthews, 1982; Morehead et al., 1992). Tidal currents generally are weak, about 4 centimeters per second (Kowalik and Proshutinsky, 1994). The level of the water changes constantly in response to the wind. Positive tidal surges occur with strong westerly winds, while negative surges occur with strong easterly winds. Roxy Ekowana stated: "Such a strong west wind…and I found out that it was also high tide" (Ekowana as cited in North Slope Borough, 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).

III.A.3.c(6) Stream and River Discharge

Hydrologic data for the North Slope are sparse (Brabets, 1996). Tables III.A-3 and A-4 show the known flow characteristics of North Slope streams and rivers that drain into the Beaufort Sea. The available data show that all streams and rivers share somewhat unique flow characteristics. Flow generally is nonexistent or at least unmeasurable 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). Most streams continue to flow throughout the summer but at relatively low discharges. Runoff is confined to the upper organic layer of soil, as the mineral soils are saturated and frozen at depths greater than 2-3 feet (Hinzman, Kane, and Everett, 1993). Rainstorms can produce increases in stream flow, but they seldom are sufficient to cause flooding. Stream flow ceases at most streams shortly after freezeup in September.

III.A.3.d. Changes in the Arctic

We do not know to what extent the recent chances in the Arctic are cyclic, whether they represent a trend, or if they are a modal shift (Morrison, Aagaard, and Steele, 2000). Widespread changes of temperature and salinity occurred in the central Arctic Ocean water column during the first half of the 1990-1999 decade. There were observations of widespread temperature increases in the Atlantic Water layer (Carmack et al., 1995; McLaughlin et al., 1996; Morrison et al., 1998; Grotefendt et al., 1998). This appears related to an increased temperature (Swift et al., 1998) and strength (Zhang et al., 1998) of the Atlantic inflow into the Arctic Basin. This warming, in turn, was associated with cyclical, large-scale shifts in atmospheric forcing (Proshutinsky and Johnson, 1997; Proshutinsky et al., 1999). Gunn and Muench (2001) report that the pronounced warming of Atlantic Water had tapered off by 1998-1999. Determining whether this trend persists depends on acquiring additional data. Additionally, the cold halocline layer, which insulates the sea ice from the relatively warm Atlantic waters, appears to have retreated from the Eurasian Basin in recent years (Steele and Boyd, 1998). This has important consequences for ice/ocean-heat exchange and ice-growth rates. The cause of the modified halocline layer likely is related to a diversion of Russian river runoff caused by atmospheric circulation anomalies.

III.A.4. Sea Ice

Sea ice is frozen ocean water with the salt leached out. The Beaufort multiple-sale area is covered by sea ice for three-quarters of the year from October until June. Sea ice has a large seasonal cycle, reaching a maximum extent in March and a minimum in September. 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 the blowing wind.

There are three major forms of sea ice in the Beaufort multiple-sale area: landfast ice, which is attached to the shore, is relatively immobile, and extends to variable distances offshore; stamukhi ice; and pack ice, which includes first year and multiyear ice, moves under the influence of winds and currents.

III.A.4.a. Seasonal Generalities

There are wide-ranging spatial and temporal variations in the Beaufort multiple-sale area; however, during an "average year," there is a general pattern.

- September when shore ice forms; the river deltas freeze; and frazil, brash, and grease ice form within bays and near the coast.
- Mid-October 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 multiple-sale area.
- Late May when rivers flood over the nearshore sea ice.
- 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).
- Early to mid-July when floating and grounded landfast ice breakup. 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 North Slope Borough, 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).

III.A.4.b. Landfast Ice

Landfast ice usually is reformed 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 out to a depth of about 2 meters. The remaining ice is floating. By late winter, first-year sea ice in the landfast-ice zone is about 2 meters thick. The landfast-ice zone extends from the shore out to the zone of grounded ice ridges. These ice ridges initially form in about 8-15 meters of water, but by late winter they may extend beyond the 20-meter isobath. Map 6 shows the monthly progression of landfast ice throughout the Arctic winter.

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 North Slope Borough, 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).

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 meters 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 meters, do not happen often; rideups beyond 100 meters are rare. The landfast ice may move several hundred meters during early winter. Shapiro and Metzner (1979), in an article on extending the observations through oral histories, reference ice motion between Narwhal Island and the coast during a storm in November or December of 1924. Bruce Nukapigak stated: "At the same time these westerly winds cause movements in the ice between the barrier island and the mainland. But this is in the fall before it gets really thick" (Nukapigak, as cited in Shapiro and Metzner, 1979). Otis Akivgak recalled: "Even the shoreside ice piled up so high [on Pole Island] that it was hard to drive our dog team on it" (Akivgak, as cited in North Slope Borough, Commission on History and Culture, 1980).

Fast ice in later winter usually moves tens of meters but may move up to several hundred meters. Deformations take the form of pileups and rideups on the coastal and island beaches and rubble fields and small ridges offshore. As the winter progresses, extensive deformation within the landfast-ice zone decreases, as the ice in the landfast zone thickens, strengthens, and becomes more resistant to deformation. Elija Kakinya stated: "Right around Flaxman Island, on the lagoon side, that is behind the barrier islands, inward to the inland, after the ice formed and freezed it never moved or any disturbance that I can recall in that area" (Kakinya, as cited in Shapiro and Metzner, 1979). Jeannie Ahkivgak stated: "The ice between the barrier islands and the mainland doesn't pile up too much. Sometimes there would be small pressure ridges in there" (Ahkivgak, as cited in North Slope Borough, Commission on History and Culture, 1980).

In the early 1970's, Archie Brower recalled that:

> A few years ago I was traveling along the coast at Bullen Point, which is inside Maguire Island west of Flaxman Island. I saw how a garage that was about 30 feet above the water line on the coast had been destroyed by ice. I was traveling in late May, but the ice was so covered with old snow that I believe that it must have destroyed the garage in February or March of that year. Ice had piled up or near the garage from about ten feet high from the surface of the ground (Brower, as cited in North Slope Borough, Commission on History and Culture, 1980).

Herman Aishana also commented on the same event

> The other thing I've seen, and this was inside the Barrier Islands, over at Camden Bay – not Camden Bay, but at Bullen Point, that old DEW Line site over there – I saw that building over there demolished by ice piling up; and the garage over there [was also demolished]. Piled right into it, year. It was quite a ways off shore. It was about 100 yards or so [offshore]…. And the [building] was sitting about, oh, maybe a little over ten feet above sea lever. It's amazing. Yeah it didn't wipe out the whole building, but it really made a mess out of it; it was a metal building (Aishana, as cited in Kruse et al., 1983a).

During public hearings, the local residents of Nuiqsut and Kaktovik have described numerous incidents where the ice has come onshore and has come up over cliffs as high as 20-40 feet. Mr. Isaak Akootchook of Kaktovik stated that: "...the current is pretty strong. It can push (ice) all the way (up on) the shore, about 20 to 30 feet high. But we haven't seen this (for) about 50 years now." During the BF Public Hearing in Nuiqsuit, Mr. Neil Allen wrote:

> I have seen how strong the ice can be. In 1929 or 1930 I was living with my brother. In December, just before Christmas a very strong west wind came up. When the weather cleared, we went over to Icy Reef and we saw that the ice had pushed up on the island. My brother measured how thick the ice was. It was as thick as the length of the pole he carried which was 5-1/2 feet long. That thick sheet of ice had pushed over the island. In those days the island was about 20 feet high and 200 feet wide (USDOI, MMS, 1979a).

Mr. Phillip Tikluk of Kaktovik stated during the BF public hearings:

> But they don't know how strong the ice movements are. I have seen the ocean when it piles up and when it moves. With a little help of wind I have seen here in Barter Island when it piles up and when it hit the beach. We have a cliff out here which is maybe thirty or forty feet high and during the month of June if I remember right the ice moved and that ice maybe five to six feet thick climbs up over the cliff that's how strong it is. The ice five feet or six feet thick right on top of the thirty or forty foot cliff. I have seen the ice move right across from the ocean side to the lagoon, blocking the airport road. The ice starts to move, it doesn't stop at anything (USDOI, MMS 1979b).

III.A.4.c. Stamukhi Ice Zone

Seaward of the landfast-ice zone is the stamukhi, or shear, zone. This 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. 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. These ridges will reach depths of 25 meters and act as sea anchors for the adjacent fast ice. 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 fast ice and the shear ice. This phenomenon is common in the Beaufort Sea.

In the Beaufort Sea, the most ridging occurs in waters that are 15-45 meters deep. As shown in Map 6, one of the characteristics of the stamukhi zone is that some portions of the ice are grounded on the seafloor. The outer edge of the stamukhi zone advances seaward during the ice season.

During the BF Public Hearings in Nuiqsut, Mrs. Bessie Ericklook describes 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, MMS, 1979a).

III.A.4.d. Pack-Ice Zone

The pack-ice zone lies seaward of the stamukhi zone and includes first-year ice, multiyear undeformed and deformed ice, and ice islands. 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 meters. Undeformed ice floes with diameters greater than 500 meters occupy about 60% of the pack-ice zone; some floes may have diameters up to 10 kilometers.

Ridges are a prominent indicator of deformed ice. The height of most ridges appears to be about 1-2 meters; ridge heights up to 6.4 meters 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-meter isobath; and (3) in the eastern Beaufort Sea 30-40 kilometers from the coast, there is an increase in ridging from east to west.

Movement of the floating ice is controlled by atmospheric systems and oceanographic circulation. During the 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 kilometers per day and (2) an actual rate of 2.2-7.4 kilometers per day, with extreme events up to 32 kilometers per day. East and northeast winds drive the ice offshore; westerly winds move the ice onshore.

During the hearing in Barrow on the Beaufort Sea multiple sales, Mr. Hopson spoke:

> You know, like anybody else, I spent a total of 11 years in the Arctic Ocean, the – six of the 11 years, I spent six years floating around. I passed by that area three times coming in from the Barter Island, you know, on the – that other side going to there, you know, and the further north you go is not too bad, but, you know, the further closer you get to the mainland, you're going to pressure cooking (ph), the inside ice is so big that you just – momentum keep going there, you know, it just pushes you right out. And this island that I was in was four and a half miles wide, eight and a half miles longs, 115 feet thick, you know, it's part of a glacier from by Osmere, by Greenland, and when we got close, within 200 (ph) miles, we started moving, you know, 15 miles on a good, windy day. Fifteen miles, three knots, sometimes we just sit there. But it's kind of vicious, you know, but people need to do study before they start putting out leases, especially in the, you know, 30, 40 miles. You know, that's vicious (USDOI, MMS, Alaska OCS Region, 2002b).

III.A.4.e. Leads and Open-Water Areas

Data obtained from aerial and satellite remote sensing show that leads and open-water areas form within the pack-ice zone. Southwesterly storms cause leads to form in the Beaufort Sea.

Along the western Alaskan coast between Point Hope and Point Barrow, there often is a band of open water seaward of the landfast-ice zone during winter and spring. This opening is at some times a well-defined lead and at other times a series of openings in the sea ice, or polynyas. Between February and April, the average width is less than 1 kilometers (the extreme widths range from a few kilometers in February to 20 kilometers in April) and is open about 50% of the time. The Chukchi open-water system appears to be the result of the general westward motion seen in the Beaufort Gyre. Also, there appears to be a positive correlation between the average ice motion away from the coast and the mean wind direction, which is from the northeast for all months except July (Stringer and Groves, 1991).

III.A.4.f. Summer Ice Conditions

By the middle of July, much of the fast ice inside the 10-meter 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 North Slope Borough, 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 North Slope Borough, 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 North Slope Borough, Commission on History and Culture, 1980).

III.A.4.g. Changes in Arctic Sea Ice

The analysis of longer-term data sets and modeling indicate substantial reductions in both the extent and thickness of the arctic sea-ice cover during the past 20-40 years (Maslanki, Serreze, and Barry, 1996; Cavalieri et al., 1997; Rothrock et al., 1999; Vinnikov et al., 1999).

The extent of arctic sea ice (the area of ocean covered by ice), as observed mainly by satellite, has decreased at a rate of about 3% per decade since the 1970's (Parkinson et al., 1999; Johannessen et al., 1999). Within Canadian arctic waters, a similar rate of decrease has been observed over the period 1969-2000. The arctic sea-ice cover shows decadal oscillations superimposed on the decreasing trend after 1960 (Dresser, Walsh, and Timlin, 2000; Wang and Ikeda, 2000).

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 meters in most of the deepwater portion of the Arctic Ocean, from 3.1 meters in 1958-1976 to 1.8 meters in the 1990's. The decrease is greater in the central and eastern Arctic than in the Beaufort and Chukchi seas. Preliminary evidence is that the ice cover has continued to become thinner in some regions during the 1990's (Rothrock, Yu, and Maykut, 1999). 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.

III.A.5. Chemical Oceanography and Water Quality

Water's physical and chemical characteristics determine the quality of the marine aquatic environment. The constituents of the water mainly are composed of naturally occurring substances at nontoxic concentrations. However, the constituents may include manmade substances and a few naturally occurring ones at toxic concentrations—pollutants.

III.A.5.a. 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 (Colville, Kuparuk, Sagavanirktok, and Canning) that flow into the Alaskan Beaufort Sea remain relatively unpolluted by human activities, but carry into the marine environment sediment particles (fine enough to be suspended) 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 (1997) entitled *Arctic Pollution Issues: A State of the Arctic Environmental Report*.

The information on chemical oceanography, water quality, and pollutants in the Sale 170 final EIS and Liberty final EIS (USDOI, MMS, 1998; USDOI, MMS, Alaska OCS Region, 2002a) are summarized herein and incorporated by reference. The descriptions are augmented by the following additional information on hydrocarbons, trace metals, and turbidity. Information on other pollutants, including dissolved oxygen and hydrogen-ion concentration (pH/acidity/alkalinity) is summarized in the Liberty final EIS (USDOI, MMS, Alaska OCS Region, 2002a).

III.A.5.a(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.

The hydrocarbons analyzed in the Beaufort Sea sediments included total resolved and unresolved saturated hydrocarbons (n-C9 through n-C40), polynuclear aromatic hydrocarbons, and triterpanes. Polynuclear aromatic hydrocarbons 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.

Hydrocarbons concentrations in the Alaskan Beaufort Sea were sampled as part of the Beaufort Sea Monitoring Program, and have been analyzed by Shaw et al.; their analyses are summarized in the Liberty final EIS (Shaw et al. as cited in USDOI, MMS, Alaska OCS Region, 2002a). The EIS points out that there is no evidence that the hydrocarbon concentrations in Beaufort Sea sediments are derived from oil-industry activities. The following is some recent additional information from recent studies, including an MMS project called the Arctic Nearshore Impact Monitoring in the Development Area (ANIMIDA).

III.A.5.a(1)(a) Total Organic Carbon

Total organic carbon content of the sediments that were sampled in 1999 as part of the 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 et al., 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.

III.A.5.a(1)(b) Saturated Hydrocarbons

For most Beaufort Sea stations, the total saturated hydrocarbon concentrations are low, ranging from 0.21-16 milligrams per kilogram (Boehm et al., 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 milligrams per kilogram and 21-32 milligrams per kilogram, respectively. 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 milligrams per kilogram, for this suite of samples was found at the station west of West Dock in Prudhoe Bay (Boehm et al., 2001). The sample from this station contained high concentrations of metals and indicated contamination from an anthropogenic source.

III.A.5.a(1)(c) Polynuclear Aromatic Hydrocarbons

Polynuclear aromatic hydrocarbon levels are within the range of values reported from previous studies in the Beaufort Sea and other areas (Boehm et al., 2001). The polynuclear aromatic hydrocarbons 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 polynuclear aromatic hydrocarbon concentration, 2,700 microgram per kilogram. This site also had a higher concentration of a number of the trace metals than did other sites. The high concentrations of polynuclear aromatic hydrocarbon indicate possible hydrocarbon contamination. The source of this contamination is discussed later in this section, where the triterpane components of the sediments are described.

Boehm et al. (2001) noted an increase in the ratios of pyrogenic to petrogenic polynuclear aromatic hydrocarbons 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 polynuclear aromatic hydrocarbon values for the station samples in 1999 are much lower than the Effects Range-Low, 4,022 micrograms per kilogram (Long and Morgan, 1990); this includes the station west of West Dock. Boehm et al. (2001) noted that polynuclear aromatic hydrocarbon concentrations in the sediments sampled did exceed the Effects Range-Low for the 13 individual polynuclear aromatic hydrocarbon compounds for which these values have been developed. Boehm et al. (2001) concluded that the polynuclear aromatic hydrocarbon 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 that was mentioned in the previous paragraphs.

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 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 polynuclear aromatic hydrocarbon assemblages in the sediments are very similar to those observed in coastal peats and river sediments. The concentrations of total polynuclear aromatic hydrocarbons range from about 21-2,185 nanograms per gram.

III.A.5.a(1)(d) Other hydrocarbons

The surface samples also were analyzed for pesticides, polychlorinated biphenyls (PCB’s), 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.

III.A.5.a(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, Alaska OCS Region, 2002a). The following is some recent additional information.

Beaufort Sea sediments 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 concentrations, and most are below known Effects Range-Low 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 is rarely 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 micrograms per gram) (Wedepohl, 1995, as reported in Boehm et al., 2001); by comparison, the average concentration of copper in the continental crust is 25 micrograms per gram. Concentrations of barium in the 1999 sediment samples ranged from 173-753 micrograms per gram; copper concentrations ranged from 4.0-46.9 micrograms per gram. 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 kilometers 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 polynuclear aromatic hydrocarbon 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 Effects Range-Low and Effects Range-Median 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 Effects Range-Low for the respective metals; the concentrations for nickel and mercury were below the Effects Range-Median.

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).

III.A.5.a(3) Turbidity

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

III.A.5.a(3)(a) Summer - Open Water

Satellite imagery and data on suspended-particulate matter suggest that in general, turbid waters are confined to waters less than 16 feet (5 meters) deep and do not extend seaward of the barrier islands. 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. Seafloor sediments in Foggy Island Bay include a heterogeneous mixture of fine sand-, silt-, and clay-size particles—particles less than 0.250 millimeter (0.01 inch) in diameter. The turbidity resulting from the floods, along with other factors, block the light and measurably reduce primary productivity of waters shallower than about 40 feet (12 meters).

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 channels in 1985 (mid-July through mid-September) ranged from 0.2-30.0 milligrams per liter (U.S. Army Corps of Engineers, 1987). 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; values ranged from 63-314 milligrams per liter for 1971-1976 (U.S. Army Corps of Engineers, 1993).

III.A.5.a(3)(b) Winter - Ice Covered

In winter, the amount of suspended sediments under the sea ice ranged from 2.5-76.5 milligrams per liter in the southeastern portion of Stefansson Sound (Montgomery Watson, 1997, 1998). Total suspended solids in the water from beneath the ice in Gwydyr Bay ranged from 7,480-26,920 milligrams per liter and from off Stump Island ranged from nondetectable to 885 milligrams per liter (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 at various depths in the water column under about 2 meters 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. Total suspended-solids measurements ranged from 0.14-0.58 milligrams per liter; turbidity measurements ranged from 0.15-0.70 nephelometric turbidity units (Boehm et al., 2001). These concentration ranges were lower than the concentrations of suspended-particulate matter 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 milligrams per liter (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 suspended-particulate matter present in the water. The amount of suspended-particulate matter depends on the meteorological and oceanographic conditions at the time. Storms in late fall could result in higher concentrations of suspended-particulate matter 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 suspended-particulate matter have decreased and there is less material to entrap in the ice.

III.A.5.b. 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), which establishes a National Pollution Discharge Elimination System (Laws, 1987). Under Section 402, the Environmental Protection Agency 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 Clean Water Act. The Clean Water Act, Section 403 (33 U.S.C. § 1343), states that no National Pollution Discharge Elimination System 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 latest information on water-quality standards for the Environmental Protection Agency is available in the most recent edition of 40 CFR (paragraph 131) or at the agency's internet web site (www.epa.gov). State of Alaska water information is available in the most recent version of 18 AAC 70 or at the Alaska Department of Environmental Conservation web site (www.state.ak.us/dec/).

III.A.6. Air Quality

The existing air quality of the entire North Slope of Alaska is superior to that set by the National Ambient Air Quality Standards and Alaska air quality laws and regulations. Concentrations of regulated air pollutants are far less than the maxima allowed. The Environmental Protection Agency calls this an attainment area, because it meets the standards of the Clean Air Act. The Prevention of Significant Deterioration program of that Act places additional limitations on nitrogen dioxide, sulfur dioxide, and total suspended-particulate matter. Table III.A-5 lists the ambient air quality standards for the program area, and Table III.A-6 lists measured air pollutants at Prudhoe Bay.

III.A.6.a Local Industrial Emissions

Over most of the onshore area adjacent to the program area, there are only a few small, scattered emissions from widely scattered sources. The only major local sources of industrial emissions are in the Prudhoe Bay/Kuparuk/Endicott oil-production complex. This area 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 more recent observations are summarized in Table III.A-6. All the values meet the State and Federal ambient air quality standards. The results appear to demonstrate that ambient pollutant concentrations, even for sites subject to maximum concentrations, meet the ambient air pollution standards. This is true even if we assume the baseline Prevention of Significant Deterioration program concentrations (determined on a site-specific basis) to be zero, limiting the allowable increase in concentrations.

III.A.6.b Arctic Haze

Although the measurements do indicate that the air quality standards are being met, some pollution nevertheless has occurred. 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). During the winter and spring, winds transport pollutants to arctic Alaska across the Arctic Ocean from industrial Europe and Asia (Rahn, 1982). These pollutants cause a phenomenon known as arctic haze. Pollutant sulfate due to arctic haze in the air in Barrow (that in excess of natural background) averages 1.5 micrograms per cubic meter. The concentration of vanadium, a combustion product of fossil fuels, averages up to 20 times the background levels in the air and snowpack. Recent observations of the chemistry of the snowpack in the Canadian Arctic also provide evidence of long-range transport of small concentrations of organochlorine pesticides (Gregor and Gummer, 1989). Concentrations of arctic haze 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 III.A-6. Model calculations indicate that less than 10% of the pollutants emitted in the major source regions is deposited in the Arctic (Pacyna, 1995). 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 1980's (Pacyna, 1995). Despite this seasonal, long-distance transport of pollutants into the Arctic, regional air quality still is far better than standards require.

III.B. Biological Resources

The following eight resource categories describe the existing biological environment:

- Lower Trophic-Level Organisms
- Fishes
- Essential Fish Habitat
- Endangered and Threatened Species (Bowhead Whales and Spectacled and Steller's Eiders)
- Marine and Coastal Birds
- Marine Mammals (Pinnipeds, Polar Bears, and Beluga and Gray Whales)

- Terrestrial Mammals (Caribou, Muskox, Grizzly Bear, and Arctic Fox)
- Vegetation and Wetlands

III.B.1. Lower Trophic-Level Organisms

Lower trophic-level organisms have been described in several Beaufort Sea EIS's; recent ones include the final EIS's for the Northstar Development Project (U.S. Army Corps of Engineers, 1999) and Sale 170 and Liberty (USDOI, MMS, 1998; USDOI, MMS, Alaska OCS Region, 2002a). The final EIS's for Sales 144 and 124 (USDOI, MMS, 1996a, 1990a) described the organisms along the entire Alaskan Beaufort Sea coast. Those documents should be consulted for background information. In this update for multiple sales over several years, information on species in the planktonic and epontic (on the undersurface of sea ice) communities will be summarized separately from information on benthic communities.

III.B.1.a. Planktonic and Epontic Communities

As explained in the Sale 170 final EIS (USDOI, MMS, 1998:Section III.B.1.a), most of the planktonic and epontic (on ice) species that occur in the sale area are distributed widely in the Arctic Ocean. Ongoing research on epontic organisms in Alaskan arctic seas indicates that those organisms might be more concentrated and productive than previously thought (Krembs, Deming, and Eichen, 2002). Other recent research illustrates the importance of plankton as prey for other animals. For example, fish and birds consume copepods, such as *Calanus*, *Neocalanus,* and *Pseudocalanus* (Shirley and Duesterloh, 2001); young ringed seals consume mostly euphausiids (Dehn et al., 2002); and bowhead whales consume copepods, euphausiids, and mysids (Lowry, 1993). The latter study showed that the same species were in the stomachs of bowhead whales that are harvested near Barter Island and near Point Barrow (Lowry, 1993), illustrating the wide distribution of zooplankton species. Plankton might be involved in the natural transfer of heavy metals in broad arctic regions. Dehn et al. (2002) show that several heavy metals possibly are transferred from water and sediments to pelagic and benthic invertebrates and then to predators. For example, they measured the concentration of total mercury in the livers (hepatic mercury) of seals from the Alaskan and Canadian arctic. They found higher mercury concentrations in ringed seals than in bearded seals, and the ringed seals from Canada had higher concentrations than those from Alaska. They concluded that the differences were probably due to the prey of the seals, because bearded seals tend to consume benthic and epibenthic prey (i.e., crustaceans and sea cucumbers) whereas ringed seals tend to consume pelagic prey (i.e., euphausiids when young and arctic cod when older).

The most productive area of the Alaskan Beaufort Sea is the coastal zone. Annual primary production along the coast to the east of Point Barrow exceeds 50 grams of carbon per year per square meter (USDOI, MMS, 1998). This high rate of production probably is due to relatively high nutrient concentrations and warm water along the coast. The coastal band of high production is illustrated in the satellite images of the distribution of phytoplankton (Figures III.B-1a and III.B-1b). The images show the concentration of cholophyll-a pigment per cubic meter, indicating the concentration of phytoplankton, or the "greenness" of the water. The red/orange colors in the figures show concentrations of pigment up to 10 milligrams per cubic meter, and the blue/purple colors in offshore waters show pigment concentrations down to 0.1 milligram per cubic meter—two orders of magnitude lower. The differences between the two figures indicate the wide range of both summer and interannual variability. The figures also show plumes of yellow/green colors that indicate moderate concentrations of phytoplankton in the western and eastern offshore portions of the Beaufort Sea. The plumes probably are due to additional nutrients from the Chukchi Sea and the MacKenzie River. The black areas show the locations of ice, clouds, and/or sediment-laden water. The narrow black band of sediment-laden water along the coast corresponds with the river deltas, estuaries, bays, lagoons, and brackish migratory corridor of anadromous fishes (Section III.B.2.c). The wider red/orange band along the coast would correspond approximately with the migratory corridor of bowhead whales [Section III.B.4.a(1)]. Together they would correspond with part of the "ring" of productive waters around the edge of the Arctic Ocean.

The region near Barter Island in the eastern Beaufort Sea was the focus of a special study of the zooplanktonic prey of bowhead whales (Richardson, 1986). As summarized in the Sale 170 final EIS (USDOI, MMS, 1998:Section III.B.1.a), the 1985-1986 field study found that the plankton was composed mostly of copepods, and the distribution was very patchy. Dense patches that bowhead whales typically feed on were found to be very extensive in the horizontal plane (for example, hundreds to thousands of meters across) but only 5-10 meters thick. Also, the patches were more abundant in nearshore and inner-shelf waters than in offshore waters. Three more years of fieldwork near Barter Island were conducted during 1998-2000 (LGL, 2002; Griffiths, Richardson, and Thomson, 2001). During a recent MMS Information Transfer Meeting, Griffiths explained that the scope and purpose of the additional fieldwork was similar to the previous study. The additional fieldwork also detected zooplankton patches with concentrations up to 700 milligrams per cubic meter, concentrations on which bowhead whales typically feed. Some of the patches were thin bands that extended for 10-15 kilometers horizontally.

Furthermore, the studies of the bowhead feeding area near Kaktovik provide information on the magnitude of natural variation, which is important for comparison with the magnitude of the probable effects of the proposed lease sale. The portion of the study by Griffiths and Thomson (2002) and Griffiths, Thomson and Bradstreet (2002) measured the abundance of zooplankton during 1985, 1986, and 1998-2000. The studies focused on large copepods—an important prey of bowhead whales—and are summarized also in bowhead whale Section III.B.4.a (1). The studies point out that predator zooplankton species were relatively abundant during the second period (1998-2000) and that the average biomass of large copepods was higher during the first 1985-1986 period than it was during the 1998-2000 period. Other studies summarize similar observations by subsistence whalers in the year-to-year variability in the feeding conditions for bowheads. The studies provide an estimate of the range of inter-annual variation in zooplankton biomass; specifically, the average biomass was about 10% less during the 1998-2000 period that it was during the 1985-1986 period (Griffiths and Thomson, 2002: Table 5.4).

The growth rates of planktonic and epontic organisms are relatively rapid, and the generation lengths are relatively short. For example, the body weight doubled every 2 weeks among immature stages of the common mysid, *Mysis litoralis*, during summer 1977-1978 field studies in Simpson Lagoon, and the generation length was 1-2 years (Griffiths and Dillinger, 1980). The rapid growth rates also were evident during formation of typical summer “blooms” during 1977 and 1978.

These studies indicate the seasonal and interannual regularity in arctic planktonic and epontic habitats. The regularity is indicated by the formation of plankton blooms during 1977 and 1978 in Simpson Lagoon. The regularity also is indicated by the formation of dense patches near Barter Island during studies conducted in 1985-1986 and 1998-2000.

III.B.1.b. Benthic Communities

Sea ice dominates the benthic and coastal habitats of the Beaufort Sea, as described by North Slope residents Norton and Weller (1984) and the Sale 170 final EIS (USDOI, MMS, 1998). The sea-ice cover is almost 100% for 9-10 months each year and freezes up to 2.5 meters thick during winter. Due to the ice cover, the shallow benthos and coastline are highly disturbed and support few large organisms. Typical organisms are the amphipods and small clams, which are the focus of the MMS-sponsored ANIMIDA study on hydrocarbon chemistry (Brown, Boehm, and Cook, 2001).

Most seafloor substrates on the Beaufort Sea OCS consist of silty sands that are gouged frequently by ice keels under ice ridges (USDOI, MMS, 1998). Grounded ice ridges and their depth distribution are illustrated in the Sale 144 and Northstar EIS’s (USDOI, MMS, 1996a:Figure III.A.4-1; U.S. Army Corps of Engineers, 1999:Figures 5.6-1, -4 and -5). Because of the disturbance from grounded ice, most of the benthic species in the proposed sale area are small and widely distributed, like small clams and mobile epibenthic amphipods.

Dunton and others have calculated the typical biomass of benthos on the Beaufort seafloor (www.utmsi.utexas.edu/staff/dunton.sbi/mywebs/data_maps.htm). The calculations include data collected during the past 3 decades of benthic studies for MMS/National Oceanic and Atmospheric Administration OCS Environmental Assessment Program and the Canadian Department of the Environment. The web site illustrates that about 30 grams per square meter of benthos grows on most of the OCS seafloor. The biomass is slightly lower in the eastern, deepwater portions of the Beaufort Sea and slightly higher in the western portion that is adjacent to the Chukchi Sea.

Dense kelp grows on a few areas of the seafloor. The distribution of kelp is limited by three main factors: ice gouging, sunlight, and hard substrate. Ice gouging restricts the growth of kelp to protected areas, such as behind barrier islands and shoals. Sunlight restricts the growth of kelp to the depth range where a sufficient amount penetrates to the seafloor, or water less than about 11 meters deep. Hard substrates, which are necessary for kelp holdfasts, also restrict kelp to areas with low sedimentation rates. These three factors have limited kelp to a few OCS areas. The best known kelp habitat is the Boulder Patch, which is located behind the barrier islands in Stefansson Sound (USDOI, MMS, Alaska OCS Region, 2002a). Kelp also grows sparsely in West Camden Bay (USDOI, MMS, Alaska OCS Region, 1998a). All likely kelp habitats have not yet been surveyed. Other kelp habitats may be discovered, as portions of the Beaufort Sea are further explored.

The Boulder Patch has been studied extensively. Its location, structure, and functioning are described extensively in the Environmental Report for the Liberty Development and Production Plan (Figure III.A-9; BPXA, 1998a:Section 4.6) and by Dunton and Schonberg (2000). The latter authors explain that the kelp grows on boulders that are gradually exposed by coastal erosion, resulting in a layer of boulders at the sediment surface (Dunton, Reimnitz, and Schonberg, 1982). The biological complexity and richness of the Boulder Patch is demonstrated by recent taxonomic studies; about 300 infaunal and epilithic species have been found (Dunton and Schonberg, 2000). The total biomass of organisms is about an order of magnitude higher than for most of the OCS seafloor; in contrast to the 30 grams per square meter of benthos on most of the OCS seafloor, about 300 grams per square meter of epilithic organisms inhabit the Boulder Patch (Dunton and Schonberg, 2000). The kelp community spreads very slowly, taking almost a decade to recolonize denuded boulders (Martin and Gallaway, 1994). The plants live a long time; Dunton observed some that probably were more than 40 years old (USDOI, MMS, Alaska OCS Region, 1998a:12).

During the MMS Arctic Kelp Workshop, Dunton explained that the growth of kelp in the Boulder Patch has varied considerably from year to year (USDOI, MMS, Alaska OCS Region, 1998a). He has records of kelp growth and light levels from 1984-1991. The data show that if the ice was clear of sediment and the plants received even a small amount of under-ice light during the spring, they grew a fair amount. For example, the growth during 1990 was exceptional, but 1988 was a really bad year for kelp growth. However, Dunton did not describe a long-term trend in the Boulder Patch, for example, from a health community to a threatened one.

The distribution and density of kelp in western Camden Bay is not as well known. During exploration of the Warthog Prospect in 1997, kelp was observed on a patch of boulders in a slight depression about 11 meters deep (Figures III.A-11 and III.A-12; USDOI, MMS, Alaska OCS Region, 1998a:Figure 3); however, the extent or density of the kelp is not well known. Kelp also has been observed shoreward in an area behind a shoal near Konganevik Point. For years, Natives have known about the rocky seafloor in this area (Jacobson and Wentworth, 1982:90), and rocks with kelp have been found on the shoreline. Overall, the kelp distribution in Camden Bay probably is limited to a few areas (1) with boulders or other hard substrate, (2) with shallow water that transmit sufficient light to the seafloor, and (3) with offshore shoals to block ice keels.

III.B.2. Fishes

Fishes inhabiting the Arctic (Figure III.B-2) must cope with harsh environmental conditions not required of their counterparts to the south. For example, during the 8-10-month winter period, freezing temperatures reduce their habitat by more than 95% (Craig, 1989). Food is very scarce during this time, and most of their yearly food supply must be acquired during the brief arctic summer (Craig, 1989). As a result, fishes inhabiting the Arctic grow slowly compared to those inhabiting warmer regions. Nevertheless, several types of fishes are year-round residents in the Arctic. They include:

- freshwater fishes that spend their entire life in freshwater (some also spend brief periods in brackish coastal waters);

- marine fishes that spend their entire life in marine waters (some also spend brief periods in brackish coastal waters); and
- migratory fishes that typically move between fresh, brackish, and marine waters for various purposes (some individual fishes do not migrate).

The freshwater environment of the Arctic Coastal Plain (from Barrow east to the Canadian border) consists of slow-moving rivers and streams in addition to lakes, ponds, and a maze of interconnecting channels. While some waterbodies are completely isolated, most are permanently, seasonally, or sporadically connected. Seasonally connected lakes are flooded during breakup, while sporadically connected lakes are flooded only during high-water years (Parametrix, Inc., 1996). Many of these waters support freshwater and migratory fish populations. At least 20 species of fishes have been collected in or near the Colville drainage system to the west (11 freshwater and 9 migratory species) (Moulton and Carpenter, 1986; Bendock, 1997). The distribution and abundance of freshwater and migratory fishes on the Arctic Coastal Plain depend on (1) adequate overwintering areas, (2) suitable feeding and spawning areas, and (3) access to these areas (typically provided by a network of interconnecting waterways) (Parametrix, Inc., 1996).

Studies on the Sagavanirktok River have shown that different fishes dominate at different times of the year:

- Summer: arctic grayling, round whitefish, Dolly Varden char (also called arctic char), broad whitefish, and slimy sculpin (Hemming, 1988; Woodward-Clyde Consultants, 1980)
- March: broad and humpback whitefish, arctic grayling, round whitefish, burbot, and slimy sculpin in the lower part of the river
- April: broad and humpback whitefish, arctic and least cisco, arctic grayling, round whitefish, burbot, and slimy sculpin
- May: broad whitefish, arctic and least cisco, arctic grayling, round whitefish, and burbot (Craig, 1989)

In winter, bodies of freshwater less than 6 feet deep are frozen to the bottom (Craig, 1989). In deeper waters that do not freeze to the bottom, the amount of dissolved oxygen is of critical importance. Flowing waters exceeding 7-10 feet in depth (depending on water velocity) generally are considered deep enough to support overwintering fishes. However, in standing waters the ice becomes thicker, and dissolved oxygen becomes less available as the winter progresses. In such cases, depths of up to 18 feet have been suggested as being the minimum required to support overwintering freshwater fishes (USDOI, BLM, 1990a).

The marine coastal environment of the Beaufort Sea consists of inlets, lagoons, bars, and numerous mudflats (USDOI, BLM, 1978a). During the open-water season, the nearshore zone of this area is dominated by a band of relatively warm, brackish water that extends across the entire Beaufort Sea coast. The summer distribution and abundance of coastal fishes (marine and migratory species) is strongly affected by this band of brackish water. The band typically extends 1-6 miles offshore and contains more abundant food resources than waters farther offshore. It is formed after breakup by freshwater input from rivers such as the Ikpikpuk, the Colville, the Sagavanirktok, and the Canning. It has its greatest extent off river-delta areas, with a plume sometimes extending 15 miles offshore.

During the open-water season, migratory fishes tend to concentrate in the nearshore area, which also is used by marine fishes and occasionally by some freshwater fishes. Migratory fishes acquire nearly all of their yearly food supplies during the brief open-water season. The areas of greatest species diversity within the nearshore zone are the river deltas (Bendock, 1997). Sixty-two species of fish have been collected from the coastal waters of the Alaskan Beaufort Sea (69% marine, 26% migratory, 5% freshwater). All (except salmon) are typical of fishes resident to arctic coastal waters from Siberia to Canada (Craig, 1984). Thirty-seven species were collected in the warmer nearshore brackish waters, and 40 species were collected in the colder marine waters farther offshore (some use both habitats). As the summer progresses, the amount of freshwater entering the nearshore zone decreases, and nearshore waters become colder and more saline. From late summer to fall, migratory fishes move back into rivers and lakes to overwinter and to spawn (if sexually mature). In winter, nearshore waters less than 6 feet deep freeze to the bottom. Before they freeze, marine fishes continue to use the nearshore area under the ice but eventually move into deeper offshore waters (Craig, 1984).

Subsistence fishermen harvest freshwater, marine, and anadromous fish in the area at differing times of the year, although the majority is harvested in summer. For example, summer fishing for whitefish happens all around the Shaviovik River Delta; and Tom cod, sculpin, ling cod, flounder, and other marine species are taken in the Foggy Island area (North Slope Borough, Commission on History and Culture, 1980). In spring, subsistence fishermen harvest arctic char as it migrates to sea and later in summer, as the char move about in nearshore waters. In fall, large migrations of whitefish and lake trout are fished along the Beaufort Sea shoreline in less than 3 feet of water. Changes in fish populations have been observed by Wilson Soplu, a subsistence fisherman, who noted that fish populations in the Shaviovik River have changed from many small fish to fewer large fish (North Slope Borough, Commission on History and Culture, 1980). For additional information concerning subsistence fishing and those harvesting fish, see Section III.C.2.

III.B.2.a. Freshwater Fishes

Freshwater fishes inhabit many of the rivers, streams, and lakes of the Arctic Coastal Plain. They include lake trout, arctic grayling, Alaska blackfish, northern pike, longnose sucker, round whitefish, burbot, ninespine stickleback, slimy sculpin, arctic lamprey, and threespine stickleback (rare). Freshwater fishes are found almost exclusively in freshwater (Moulton and Carpenter, 1986). Those with access to rivers, such as the Colville and Sagavanirktok (for example, arctic grayling), are sometimes found in the nearshore band of brackish coastal water described earlier. All of the freshwater species mentioned have been collected near the mouth of the Colville River during summer (USDOI, BLM, 1978a); however, their presence in the coastal environment is sporadic and brief, with a peak occurrence expected during or immediately following spring breakup.

Many of the streams on the Arctic Coastal Plain serve as interconnecting links to the many lakes in the area (Bendock, 1997). Some waters are used primarily as nursery areas, others for feeding, others for spawning and/or overwintering, and others as corridors linking these areas together. Juvenile fishes prefer the warmer shallow-water habitats that become available during the ice-out period (Hemming, Weber, and Winters, 1989). The most abundant freshwater fish is the ninespine stickleback (Hemming, 1996). The highest numbers are found in waters having emergent and submerged vegetation suitable for spawning and rearing, with overwintering sites nearby (Hemming, 1993). In streams, the most common freshwater fishes include arctic grayling, ninespine stickleback, and slimy sculpin (Netsch et al., 1977; Bendock and Burr, 1984). In lakes, the most common freshwater fishes include lake trout, arctic grayling, round whitefish, and burbot. Older lake fishes usually are dominant. In general, the larger, deeper, clearer lakes with outlets and suitable spawning areas are more likely to support fish. Smaller lakes that are more shallow and turbid, without outlets or suitable spawning areas, are not likely to support fish (Netsch et al., 1977; USDOI, BLM, 1978a). Bodies of freshwater less than 6 feet deep generally do not have resident fish populations, although some may be used during summer for feeding, rearing, or as access corridors to other waters.

Freshwater fishes feed on terrestrial and aquatic insects and their larvae, zooplankton, clams, snails, fish eggs, and small fishes (Bendock and Burr, 1984; USDOI, BLM, 1978a; Hemming, Weber, and Winters, 1989). Lake trout and burbot are reported to forage heavily on least cisco, round whitefish, grayling, and particularly on slimy sculpin and ninespine stickleback. Lake trout also have been reported to feed on voles (USDOI, BLM, 1978b) and burbot on Arctic lamprey (Bendock and Burr, 1984). Except for burbot, which spawns under ice in late winter, freshwater fishes spawn from early spring to early fall in suitable gravel or rubble. With the onset of winter, freshwater fishes move into the deeper areas of lakes, rivers, and streams. Smaller rivers such as the Kadleroshilik River support only small numbers of ninespine stickleback, Dolly Varden (a migratory species), and arctic grayling (Hemming, 1996).

III.B.2.b. Marine Fishes

Both marine and migratory fishes inhabit coastal waters. Marine fishes include arctic cod, saffron cod, twohorn (uncommon) and fourhorn sculpins, Canadian eelpout, arctic flounder, capelin, Pacific herring (uncommon), Pacific sand lance (uncommon), and snailfish (Craig, 1984; Moulton and Carpenter, 1986). Marine fishes prefer the colder, more saline coastal water seaward of the nearshore brackish-water zone described earlier. As summer progresses, the nearshore zone becomes more saline due to decreased freshwater input from rivers and streams. During this time, marine fishes often share this same nearshore environment with migratory fishes, primarily to feed on the abundant epibenthic fauna or to spawn (Craig, 1984). In the fall, when migratory fishes have moved out of the nearshore area and into freshwater systems to spawn and overwinter, marine fishes remain in the nearshore area to feed.

Common marine fishes in the nearshore area include fourhorn sculpin and capelin (Schmidt, McMillan, and Gallaway, 1989; Thorsteinson, Jarvela, and Hale, 1991). Saffron cod, arctic flounder, and snailfish also use the nearshore area; however, their occurrence is sporadic and variable and in much lower numbers. Common marine fishes in waters farther offshore include arctic cod and kelp snailfish (Craig, 1984; Schmidt, McMillan, and Gallaway, 1989; Thorsteinson, Jarvela, and Hale, 1991). Arctic cod are infrequent visitors to nearshore habitats during the first portion of the open-water season when waters are warmest and salinities are low (Craig et al. 1982). Arctic cod have been found to be more concentrated along the interface between the warmer nearshore water and colder marine water. The warmer nearshore zone with its more moderate salinity is thought to be an essential nursery area for juvenile arctic cod (Cannon, Glass, and Prewitt, 1991). Nevertheless, adults and juveniles are abundant in both nearshore and offshore waters and contribute significantly to productivity in arctic coastal waters. Because of the significant contribution they make to the diets of marine mammals, birds, and other fishes, arctic cod have been described as a "key species in the ecosystem of the Arctic Ocean" (Craig, 1984). They are believed to be the most significant consumer of secondary production in the Alaskan Beaufort Sea (Frost and Lowry, 1983) and even to influence the distribution and movements of marine mammals and seabirds (Craig, 1984, citing Finley and Gibb, 1982).

Marine fishes in the area primarily feed on marine invertebrates. They rely heavily on epibenthic and planktonic crustacea such as amphipods, mysids, isopods, and copepods. Flounders also feed heavily on bivalve mollusks, while fourhorn sculpins supplement their diets with juvenile arctic cod. Because the feeding habits of marine fishes are similar to those of migratory fishes (amphidromous and anadromous species), some marine fishes are believed to compete with migratory fishes for the same prey resources (Craig, 1984; Fechhelm et al., 1996). Competition is most likely to occur in the nearshore brackish-water zone, particularly in or near the larger river deltas, such as the Colville and the Sagavanirktok. As the nearshore ice thickens in winter, marine fishes continue to feed under the ice but eventually leave as the ice freezes to the bottom some 6 feet thick. Seaward of the bottomfast ice, marine fishes continue to feed and reproduce in nearshore waters all winter (Craig, 1984). Most spawn during the winter, some in shallow coastal waters, and others in offshore waters. Arctic cod spawn under the ice between November and February (Craig and Halderson, 1981). Snailfish spawn farther offshore by attaching their adhesive eggs to a rock or kelp substrate.

III.B.2.c. Migratory Fishes

The members of this group commonly are referred to as anadromous fishes. They are born and reared in freshwater, migrate to sea as juveniles, and return to freshwater as adults to spawn and die. Migratory fishes indigenous to the arctic environment (amphidromous species) differ substantially from migratory fishes inhabiting warmer waters to the south (anadromous species). Amphidromous fishes live much longer, grow much slower, and become sexually mature much later in life. Additionally, they do not make one far-ranging ocean migration and return years later to freshwater to spawn and die like anadromous fishes (for example, salmon). Instead, they make many migrations between freshwater and the sea for purposes other than just spawning. Unlike anadromous fishes, amphidromous fishes spend much more time in brackish coastal waters than they do in marine waters. Additionally, they return to freshwater to overwinter, not necessarily to spawn. In fact, amphidromous fishes typically return many times to freshwater before reaching spawning age. Even after reaching spawning age, spawning occurs only if their nutritional requirements were met during the brief arctic summer. When they do spawn, they do not necessarily die; some return years later to spawn again before dying. Despite these major differences, the term amphidromous is seldom used when referring to the indigenous migratory fishes of the arctic environment (Craig, 1989). For this reason and because the term anadromous is misleading, this review simply refers to this group of mostly amphidromous species as migratory fishes.

Migratory fishes inhabit many of the lakes, rivers, streams, interconnecting channels, and coastal waters of the North Slope. Common migratory fishes include arctic cisco, least cisco, Bering cisco, rainbow smelt, humpback whitefish, broad whitefish, Dolly Varden char (formerly known as arctic char), and inconnu.

The highest concentration and diversity of migratory fishes in the area occurs in river-delta areas, such as the Colville and the Sagavanirktok (Bendock, 1997). The most common migratory fishes in nearshore waters are arctic and least cisco (Craig, 1984). Lakes that are accessible to migratory fishes typically are inhabited by them in addition to the resident freshwater fishes. Least cisco is the most abundant migratory fishes found in these lakes.

Salmon (anadromous species) are uncommon in the North Slope region (see Table IV.C.1), are thought to be strays by most researchers, and typically contribute little (if anything) to annual subsistence and commercial harvests. Small runs of pink and chum salmon sometimes occur from the Colville River and in some drainages west of the Colville River. During the 1977-1978 sampling season, Bendock (1979) reported taking 35 chum salmon in the lower reaches of the Colville River. However, neither species has established populations anywhere in the area (Bendock and Burr, 1984). In recent years, chum smolts have been caught in the lower delta (Moulton 1999, 2001). Chum salmon accounts for a very small portion of the total fall subsistence catch (Pederson and Shishido 1988; Moulton and Field 1988, 1991, 1994, Moulton, Field, and Brotherton, 1986; Moulton et al, 1990, 1992, 1993; Moulton 1994, 1995, 1996, 1997).

Small runs also may occur in rivers closer to Barrow. Small numbers of chum are taken in the Chipp River and in Elson Lagoon, including adults in spawning condition (George, pers. commun., as cited in Fechhelm and Griffiths, 2001). Despite the presence noted, chum salmon are rare in the Beaufort Sea coastal waters, particularly east of the Colville River.

While the occurrence of salmon east of the Colville River is rare, small numbers of pink salmon occasionally have been taken in the Sagavanirktok River; however, spawning is not known to have occurred there (Wilson, 2002, pers. commun.; Fechhelm and Griffiths, 2001, citing Griffiths et al., 1983). Summer surveys along the coast of the Arctic National Wildlife Reserve by the Fish and Wildlife Service from 1988-1991 yielded 42 pink salmon in 1,788 net days of fyke-net fishing effort, and all were collected west of and including the Barter Island area (Underwood et al, 1995). Pink salmon occur in the Sagavanirktok River. During August 1982, 41 fish were collected in the lower river, 19 were caught at the mouth of the Sagavanirktok, and 8 more were caught upriver in the west channel near the Sagavanirktok Bridge where several spawned out adults also were observed (Griffiths et al., 1983). Between 1981 and 1997, only 276 individual fish were caught in Sagavanirktok River (Fechhelm and Griffiths, 2001). It is possible that random small schools of pink salmon from western stocks spawn in the Sagavanirktok River on a chance basis.

With the first signs of spring breakup (typically June 5-20), adult migratory fishes (and the juveniles of some species) move out of freshwater rivers and streams and into the brackish coastal waters nearshore. They disperse in waves parallel to shore, each wave lasting a few weeks or so. Some disperse widely from their streams of origin (for example, arctic cisco and some Dolly Varden char). Others, like broad and humpback whitefish and least cisco, do not; and they are seldom found anywhere but near the mainland shore (Craig, 1984). Most migratory fishes initiate relatively long and complex annual migrations to and from coastal waters (Bendock, 1997). However, some populations of Dolly Varden char, least cisco, and broad and humpback whitefish never leave freshwater (Craig, 1989). Many believe that arctic cisco in the Colville River area originated from spawning stocks of the Mackenzie River in Canada (Gallaway et al., 1983; Fechhelm and Fissel, 1988; Fechhelm and Griffiths, 1990). There are reports from fishermen that arctic cisco in spawning condition have been caught in at least the upper Colville and Chipp rivers (Moulton, Fawcett, and Carpenter, 1985, citing Matumeak, 1984, pers. commun.). However, the scientific evidence is overwhelming that the vast majority of the arctic cisco inhabiting the Alaskan Beaufort Sea were carried there from Canada by westerly currents.

During the 3-to-4-month open-water season that follows spring breakup, migratory fishes accumulate energy reserves for overwintering, and, if sexually mature, they spawn. They prefer the nearshore brackish-water zone, rather than the colder, more saline waters farther offshore. While their prey is concentrated in the nearshore zone, their preference for this area is believed to be more correlated with its warmer temperature (Craig, 1989; Fechhelm et al., 1993). Migratory fishes are more abundant along the mainland and island shorelines, but they also inhabit the central waters of bays and lagoons. Larger fishes of the same species are more tolerant of colder water (for example, Dolly Varden char and arctic and least ciscoes) and range farther offshore (Moulton, Fawcett, and Carpenter, 1985; Thorsteinson, Jarvela, and

Hale, 1991). Smaller fishes are more abundant in warmer, nearshore waters and the small, freshwater streams draining into the Beaufort Sea (Hemming, 1993).

Infaunal prey density in the nearshore substrate is very low and provides little to no food for migratory fishes. However, prey density in the nearshore water column is high, about five times that of freshwater habitats on the Arctic Coastal Plain. The nearshore feeding area also is much larger than that of freshwater habitats on the coastal plain (Craig, 1989). For these reasons, both marine and migratory fishes come to feed on the relatively abundant prey found in nearshore waters during summer. Migratory fishes feed on epibenthic mysids and amphipods (often greater than 90% of their diet) and on copepods, fishes, and insect larvae (Craig and Haldorson, 1981; Craig et al., 1984; Craig, 1989). In early to midsummer when migratory fishes are most abundant in nearshore waters, little dietary overlap is observed among them. However, in late summer when they are less abundant and their prey is more abundant, dietary overlap is common in nearshore waters (Moulton, Fawcett, and Carpenter, 1985). Marine birds also compete for the same food resources during this time. Migratory fishes do little to no feeding during their migration back to freshwater and when spawning, but some resume feeding during winter. Most migratory fishes return to freshwater habitats in the late summer or fall to overwinter and, if sexually mature, to spawn. Others, such as cisco and whitefish, return much earlier, arriving 6-10 weeks before spawning starts, thus forfeiting about half of the nearshore-feeding period (Craig, 1989). Char, ciscoes, and whitefish spawn in streambed gravels in fall in the Sagavanirktok River. Spawning in the arctic environment can take place only where there is an ample supply of oxygenated water during winter. Because of this and the fact that few potential spawning sites can meet this requirement, spawning often takes place in or near the same area where fishes overwinter (Craig, 1989).

III.B.3. Essential Fish Habitat

III.B.3.a. Regulations Enacting the Sustainable Fisheries Act

The 1996 Sustainable Fisheries Act enacted additional management measures to protect commercially harvested fish species from overfishing. Along with reauthorizing the Magnuson-Stevens Fishery Conservation and Management Act Reauthorization (16 U.S.C. 1801-1882), one of those added measures is to describe, identify, and minimize adverse effects to essential fish habitat. The regulations defining essential fish habitat are in 50 CFR 600.910. Essential fish habitat is defined as habitat necessary to the species for spawning, breeding, feeding, or growth to maturity.

Those habitats include:

- aquatic areas;
- their associated physical, chemical, and biological properties that are used by fish;
- sediment, hard bottom, and structures underlying the waters; and
- associated biological communities.

The Act also requires Federal Agencies to consult with the National Marine Fisheries Service on activities—in this case, offshore oil and gas leasing and development—that may adversely affect the essential fish habitat of managed harvested marine fish species. That consultation should be consolidated with environmental review required by other statutes, such as the National Environmental Policy Act (50 CFR 600.920(e)). Therefore, sections entitled essential fish habitat are included in this EIS. The essential fish habitat regulation (50 CFR 600.920(f)) enables the National Marine Fisheries Service to make a finding that an existing consultation or environmental review procedure can be used to satisfy the consultation requirements of the Magnuson-Stevens Act. A National Finding was agreed upon by MMS with the National Marine Fisheries Service on April 4, 2002, which allows that MMS may choose to use the National Environmental Policy Act process as a vehicle for the essential fish habitat consultation by submitting to the National Marine Fisheries Service, among other options, lease-sale EIS's rather than stand-alone essential fish habitat assessments.

The potentially impacting activities may have effects on essential fish habitats that are direct effects (for example, physical disruption) or indirect (for example, loss of prey species that are necessary for feeding). Those effects can be site-specific, habitatwide, individual, cumulative, and/or synergistic.

In the Alaskan offshore, essential fish habitats are designated in the fishery-management plans of the North Pacific Fisheries Management Council, the regulatory body for managing marine fisheries in Alaska. The only essential fish habitat designated in the Beaufort Sea is for salmon (Amendment 5 of the Fishery Management Plan for the Salmon Fisheries in the exclusive economic zone of the Coast of Alaska). Salmon includes all five species of Pacific salmon: chinook or king (*Oncorhynchus tshawytscha*), coho or silver (*O. kisutch*), pink or humpy (*O. gorbuscha*), sockeye or red (*O. nerka*), and chum or dog (*O. keta*) (North Pacific Fisheries Management Council, 1997).

Essential fish habitat is defined by whether it could ever be used, given climate change, seismic changes, etc and does not consider if it is currently used by salmon. Salmon essential fish habitat in freshwaters of Alaska is designated as virtually all the coastal streams to about 70° N. latitude. Salmon essential fish habitat in marine waters of Alaska formally is designated as the area within the 320 kilometer exclusive economic zone boundary of the United States down to a depth of 500 meters (North Pacific Fisheries Management Council, 1999). Salmon essential fish habitat is defined to the outer boundary of the exclusive economic zone and to a depth of 500 meters, while the written descriptions of salmon indicate that in the juvenile marine stage, they (all five species) head to the Bering Sea and south to the Gulf of Alaska for this stage (North Pacific Fisheries Management Council, 1999).

Habitat areas of particular concern (HAPC) include nearshore areas of intertidal and submerged vegetations, rock, and other substrates. Shallow nearshore estuarine and marine habitats including submerged aquatic vegetations and emergent vegetation are habitat areas of particular concern used by Pacific Salmon. Substrates of high-micro habitat diversity serving as cover from groundfish and other organisms such as areas rich in epifauna communities or substrate with large participle size such as the Boulder Patch. Streams and lakes and other freshwater areas used by Pacific salmon and other anadromous fish (such as smelt), especially located near urban areas or areas with intensive human-induced developmental activities also are habitat areas of particular concern (North Pacific Fisheries Management Council, 1999).

The salmon themselves also are to be evaluated (National Marine Fisheries Service, 2002). Generally, there is little evidence of viable self-sustaining salmon populations in the Beaufort Sea. Present salmon "populations" have a very difficult time establishing and persisting, most likely because of the marginal habitats (Craig, 1989; Fechhelm and Griffiths, 2001). Conclusions based on a survey of available information describing salmon stocks in the Beaufort Sea (Fechhelm and Griffiths, 2001) indicate only a few isolated spawning stocks of chum and pink salmon that might occur in the Beaufort Sea area, primarily the Sagavanirktok and Colville rivers. Their database shows only one to two chum per year on average caught in sampling gear in the last 30 years. These authors believe chum and pink taken in the Chipp River and Elson Lagoon near Point Barrow could be either individuals of small runs or an overshoot of spawning salmon from near Point Hope and along the Chukchi Sea coast. Sockeye, coho, and king salmon are even rarer than pink and chum salmon in the Beaufort Sea. For example, no sockeye or coho salmon and only a single chinook salmon were collected during 17 seasons of intensive sampling in Prudhoe Bay (Babaluk et al., 2000). Salmon generally make up less than 1% of the subsistence fish catch with spikes of 3-4% in a few years (State of Alaska, Dept. of Fish and Game, 1995b; North Slope Borough, 2000). Based on the above information, we conclude there are no self-sustaining salmon populations and that the small number of salmon caught are strays from the Chukchi or Bering Sea populations.

Recent occurrences raise the question of whether significant temperature increases in arctic areas caused by climate change indicate a significant change in salmon distribution in the future. Local residents have noticed increases in salmon occurrences over the past 10-20 years (Pedersen, 1995; Napageak, 1996). Several published journal notes of first records of salmon in the Canadian Beaufort Sea watershed that occurred in the past decade (Babaluk et al., 2000) also indicate the increasing but still rare incidence of salmon in the Beaufort Sea. Potential effects of global warming are further addressed in a subsequent section of this document.

Ecologically, the Beaufort Sea can be considered a population sink for salmon rather than a source, drawing excess salmon from other areas rather than producing a surplus that colonizes new areas. The scarcity of salmon documented in the Beaufort Sea and the fact that it is at the northern boundary of the geographic distribution support the population sink theory. Additionally, while still uncommon across the Beaufort Sea, more salmon have been documented more frequently in the west than the east. This seems to reflect locations nearer the sources of the larger and more concentrated salmon populations in the Bering and Chukchi seas.

Beyond the physical proximity to source populations, ocean currents tend to bring more nutrients to the western portion of the Beaufort Sea, making potential habitat better in the west than the east. Other physical differences such as temperature and salinities seem to differ little east to west (Okkonen and Stockwell, 2001). Thus, effects of the same type and size of disturbance (for example, seismic activity, turbidity from construction, or an oil spill) or the same size of deferral at the same distance from the shoreline can be expected to have a slightly greater effect in the western Beaufort than in the central and eastern Beaufort.

III.B.3.b. Salmon Essential Fish Habitat Components and Seasons in the Beaufort Sea

See Table III.B-1 for salmon essential fish habitat components, seasons, and areas of freshwater, estuary, and marine habitat in the Beaufort Sea multiple-sale area.

Freshwater overwintering habitat, including spawning gravel that does not freeze and kill eggs, is extremely limited in the Beaufort Sea coast area and probably is the largest controlling factor limiting the viability of Beaufort Sea salmon stocks (Craig, 1989; Fechhelm and Griffiths, 2001). Most benthic invertebrates, such as insects living on the stream bottom and insects and many zooplankton living in the water column (such as copepods), are freshwater prey for one or another species of salmon.

For salmon, these freshwater overwintering areas comprise primarily spawning habitat, which also is the egg and larvae habitat for up to 11 months after spawning. For this analysis, the egg-through-alevin stages of all five species of Pacific salmon are combined. Juveniles of pink and chum salmon, the most common and most adapted salmon to the Beaufort environment, do not require juvenile freshwater rearing habitat, because the young hatch in early spring and soon after migrate to saltwater. Coho, sockeye, and king salmon require year-round juvenile rearing habitat for 1-3 years. Sockeye require freshwater lake rearing habitat for 18 months to 2 years.

Habitat areas of particular concern are designated by regulation to be all freshwater anadromous streams and lakes. For purposes of analysis, anadromous freshwater habitat is calculated by summing the total length of State-identified anadromous streams and lakes from the northern coast south to present or potential onshore pipeline locations, approximately 687 kilometers of streams and rivers.

A 5-mile-wide region of brackish or less salty water, called the estuarine habitat, could theoretically support young salmon as they exit freshwater for life in the sea. In early summer (i.e., mid-June to mid-July) (Niedoroda and Colonell, 1988), significant inputs of freshwater from coastal runoff lowers the salinity in these waters to 28 physical salinity units (Weingartner and Okkonen, 2001) compared to 33.1 physical salinity units farther out from the coast (Lewbel and Gallaway, 1984; Okkonen and Stockwell, 2001; Pickart, 2001). Temperature and salinity differences within the estuarine belt are due primarily to winds. As freshwater discharge becomes low by late summer, brackish water becomes saltier. In October, landfast ice begins forming. From November to June, this 5-mile wide estuarine zone is frozen solidly to the ocean floor (Nukapigak, as cited in USDOI, MMS, 1995a). See Section III.A.3 Oceanography for more detail.

This estuarine zone is used primarily by juvenile salmon smolt during physiological adaptation to the saltwater environment from the freshwater. This outmigration takes place from the time the ice moves out through August. Feeding during this time, especially the first few days, is thought to be especially critical to survival. Salmon smolt must catch and eat prey within just a few days or die. Thus, prey and prey habitat are an important part of this particular habitat. Once they enter the ocean, pink and chum salmon smolt hug the shore. Pink salmon spend the first few weeks in water only a few centimeters deep; thus prey living in the gravel substrate (benthic insects and zooplankton) are their primary food source. Chum salmon use intertidal areas (i.e., estuarine waters in the Beaufort Sea) for months before migrating to the outside waters. They move offshore from July to September. Sockeye juveniles also tend to stay close to the shore during their first summer (North Pacific Fisheries Management Council, 1997). For purposes of analysis, we define the estuarine habitat as an approximately 5-mile wide zone adjacent to the Beaufort Sea coast, an area of approximately 715,000 hectares.

Salmon reportedly are caught in August in the Colville River subsistence fishery, but not in high numbers (George and Nageak, 1986). Strays attempting to spawn will transit the estuarine zone and may wait there while their osmoregulatory system adapts from saltwater back to freshwater for spawning. Otherwise, the salinity is not an important aspect for adults returning to spawn between June and September. Individual fish probably will take only a few days to a week to transit this estuarine area in the Beaufort Sea.

The marine juvenile stage is the principal growth period of salmon and can last from 1-6 years. During this lifestage, prey and prey habitat are the most critical components of the marine essential fish habitat. Prey commonly is animals near the water surface (epipelagic zooplankton), particularly copepods. Given their differences in size, this is a surprising overlap with the bowhead whale, which strains plankton through baleen. Chinook (king) salmon and larger sockeye coho and chum salmon also consume fish.

Marine essential fish habitat technically extends north to the exclusive economic zone from the estuarine zone. The marine salmon essential fish habitat associated with this lease sale extends from the estuarine band (to 5 miles from the coast) to the northern sale-area boundary, an area of approximately 4 million hectares.

However, according to the preliminary assessment report for essential fish habitat, this stage historically does not involve the Beaufort Sea. Pink salmon occupy marine waters south of 60º N. latitude, coho salmon south of 64º N. latitude, chinook salmon in the Bering Sea 70º N. latitude and south, pink salmon south of the Bering Straight (about 65º N. latitude), and sockeye salmon in the larger Gulf of Alaska and the Pacific Rim. Temperature may explain most of this difference, because the Beaufort Sea ranges between -1.7° and -1.3° Celsius in the top layers (Okkonen and Stockwell, 2001), whereas coho salmon, for instance, prefer 12-15° Celsius (North Pacific Fisheries Management Council, 1997).

III.B.4. Endangered and Threatened Species

III.B.4.a. Endangered and Threatened Species in or Near the Planning Area

The Endangered Species Act of 1973 defines an endangered species as any species that is in danger of extinction throughout all or a significant portion of its range. The act defines a threatened species as one that is likely to become endangered within the foreseeable future. Endangered bowhead whales and threatened spectacled and Steller's eiders (birds) may occur near prospective oil and gas development sites in the Beaufort Sea.

III.B.4.a(1) Bowhead Whales

The bowhead whale was listed as endangered on June 2, 1970. No critical habitat has been designated for the species. The National Marine Fisheries Service received a petition on February 22, 2000, requesting that portions of the U.S. Beaufort and Chukchi seas be designated as critical habitat for the Western Arctic stock (Bering Sea stock) of bowhead whales. On August 30, 2002, the National Marine Fisheries Service made a determination not to designate critical habitat for this population of bowheads (67 *FR* 55767) because: (1) the population decline was due to overexploitation by commercial whaling, and habitat issues were not a factor in the decline; (2) the population is abundant and increasing; (3) there is no indication that habitat degradation is having any negative impact on the increasing population; and (4) existing laws and practices adequately protect the species and its habitat.

Regarding the listing status of bowhead whales, Shelden et al. (2001) propose that the bowhead whale species should be listed as five distinct population segments, based on the distinct population segment definition developed by the National Marine Fisheries Service and the Fish and Wildlife Service in 1996. The five separate stocks of bowhead whales are the Bering Sea stock (Western Arctic stock), the Spitsbergen stock, the Davis Strait stock, the Hudson Bay stock, and the Okhotsk stock. Shelden et al. (2001) evaluated each proposed distinct population segment to determine whether one or more should be reclassified. The authors used two alternative approaches to determine the status of bowhead whales, the classification system established by the IUCN (World Conservation Union, 1996, as referenced in Shelden et al., 2001) and the method developed by Gerber and DeMaster (1999, as referenced in Shelden et al., 2001) for Endangered Species Act classification of North Pacific humpback whales. Under each of these classification systems, the authors determined that the Bering Sea population of bowhead whales should be delisted, whereas the other four populations of bowheads should continue to be listed as endangered.

The Western Arctic stock of bowhead whales was estimated to be 8,000 individuals in 1993, with a 95% confidence interval from 6,900 and 9,200 individuals (Zeh, George, and Suydam, 1995; Hill and DeMaster, 1999). Zeh, Raftery, and Schaffner (1995) subsequently revised this population estimate by incorporating acoustic data that were not available when the earlier estimate was developed. The revised estimate of the population was estimated between 7,200 and 9,400 individuals in 1993, with 8,200 as the best population estimate, and the estimate recognized by the International Whaling Commission. This revised population estimate is also the population estimate used by the National Marine Fisheries Service in their stock assessments (Hill and DeMaster, 1999; Ferrero et al., 2000; Angliss, DeMaster, and Lopez, 2001). An alternative method produced an estimate of 7,800 individuals, with a 95% confidence interval of 6,800-8,900 individuals. Zeh, Raftery, and Schaffner (1995) estimate that the Western Arctic stock increased at a rate of 3.2% per year from 1978-1993. The increase in the estimated population size most likely is due to a combination of improved data and better censusing techniques along with an actual increase in the population. During the spring 2001 bowhead census, 3,295 bowhead whales were counted during the visual count (*The Arctic Sounder*, 2001). Following the census, the North Slope Borough Department of Wildlife Management estimated that the population of bowheads is increasing at the rate of about 4% per year. The current best bowhead whale population estimate for 2001 is 9,860 with a 95% confidence interval of 7,700-12,600 (George et al., 2002). This is a preliminary estimate and may be refined further by incorporating additional information on acoustic locations. The new preliminary estimate for 2001 results in an estimated rate of increase of the population of 3.3% (95% confidence interval of 2%, 4.7%) from 1978-2001(George et al., 2002). The number of calves counted in 2001 (121) is nearly twice the number counted in 1993 (66) and the highest ever recorded. Using the preliminary population estimate of 9,860, NOAA Fisheries estimates the minimum population of bowhead whales in the Western Arctic stock at 8,886 (Angliss and Lodge, 2002, draft). The most recent population census shows a substantial increase over the previous population count of 8,200 whales and shows the population is approaching the lower limits of the historical population. The historic population was estimated at 10,400-23,000 whales in 1848, before commercial whaling, compared to an estimate of between 1,000-3,000 animals in 1914, near the end of the commercial-whaling period (Woody and Botkin, 1993).

The Western Arctic stock (Bering Sea stock) of bowhead whales migrates through the Alaskan Beaufort Sea semiannually between wintering areas in the Bering Sea and summer feeding grounds in the Canadian Beaufort Sea.

Bowhead whales have an affinity for ice and are associated with relatively heavy ice cover and shallow continental shelf waters for much of the year. Throughout the winter, bowheads frequent the marginal ice zone, regardless of where the zone is, and polynyas (irregular areas of open water). Polynyas in the Bering Sea along the northern Gulf of Anadyr, south of St. Matthew Island, and near St. Lawrence Island, are important wintering areas for bowheads. Bowheads also congregate in these polynyas before starting their spring migration (Moore and Reeves, 1993).

The bowheads' northward spring migration appears to coincide with ice breakup. They pass through the Bering Strait and eastern Chukchi Sea from late March to mid-June through newly opened leads in the shear zone between the shorefast ice and the offshore pack ice. The migration takes place in pulses, or aggregations of whales swimming together, with the first pulse passing Point Barrow in late April or early May, the second pulse in mid-May, and a less-well-defined pulse in late May to mid-June (Moore and Reeves, 1993). Several studies of acoustical and visual comparisons of the bowhead's spring migration off Barrow indicate that bowheads also may migrate under ice within several kilometers of the leads. Data from several observers indicate that bowheads migrate underneath ice and can break through ice 14-18 centimeters (5.5-7 inches) thick to breathe (George et al., 1989; Clark, Ellison, and Beeman, 1986). Bowheads may use cues from ambient light and echoes from their calls to navigate under ice and to distinguish thin ice from multiyear floes (thick ice). After passing Barrow from April through mid-June, they move easterly through or near offshore leads. East of Point Barrow, the lead systems divide into many branches that vary in location and extent from year to year. Andrew Oenga, who hunted bowhead whales as a crew member out of Barrow from 1943-1960 stated: "I believe from my experience that bowhead whales would reach the leads offshore from Prudhoe Bay by early May" (Oenga, as cited in U.S. Army Corps of Engineers, 1999). The spring-migration route is far offshore of the barrier islands in the central Alaskan Beaufort Sea. Bowheads arrive on their summer feeding grounds near Banks Island from mid-May through June and remain in the Canadian Beaufort Sea and Amundsen Gulf until late August or early September (Moore and Reeves, 1993).

Some biologists conclude that almost the entire Bering Sea bowhead population migrates to the Beaufort Sea each spring and that few whales, if any, summer in the Chukchi Sea. However, some scientists maintain that a few bowheads swim northwest along the Chukotka coast in late spring and summer in the Chukchi Sea. Incidental sightings suggest that bowhead whales may occupy the northeastern Chukchi Sea in late summer more regularly than commonly believed (Moore, 1992). Records of bowhead sightings from 1975-1991 suggest that bowheads may occur regularly along Alaska's northwestern coast in late summer; however, no one has yet established if these are "early-autumn" migrants or whales that have summered nearby (Moore et al., 1995). Harry Brower, Jr., stated that he has seen whales in the Barrow area in the middle of the summer while the hunters are out hunting bearded seals on the ice edge (Brower, as cited in USDOI, MMS, 1995b). The monitoring program conducted while towing the SDC to the McCovey location in 2002 recorded five bowhead whales off Point Barrow on July 21. Bowheads found in the Bering and Chukchi seas in the summer may be part of the expanding Western Arctic stock (DeMaster, et al., 2000, as referenced in Angliss, DeMaster, and Lopez, 2001).

After summer feeding in the Canadian Beaufort Sea, bowheads begin moving westward into Alaskan waters in August and September. Generally, few bowheads are seen in Alaskan waters until the major portion of the migration takes place, typically between mid-September and mid-October. In some years bowheads are present in substantial numbers in early September. Greene and McLennan (2001) reported detecting substantial rates of bowhead whale calls on September 2-3 while conducting acoustic monitoring studies around the Northstar Project. In 1997, Treacy (1998) reported sighting 170 bowheads, including 6 calves, between Cross Island and Kaktovik on September 3, during the first flight of the survey that year. There is some indication that the fall migration, just as the spring migration, takes place in pulses or aggregations of whales (Moore and Reeves, 1993). Braham et al. (1984, as reported in Moore and Reeves, 1993) reiterated the contention of Eskimo whalers that bowheads are segregated roughly by age class, with smaller whales preceding large adults and cow-calf pairs on the fall migration. Inupiat whalers estimate that bowheads take about 2 days to travel from Kaktovik to Cross Island, reaching the Prudhoe Bay area in the central Beaufort Sea by late September, and 5 days to travel from Cross Island to Point Barrow (T. Napageak, 1996, as cited in National Marine Fisheries Service, 1999).

Wartzog et al. (1989) placed radio tags on bowheads and tracked the tagged whales in 1988. One tagged whale was tracked for 915 kilometers as it migrated west at an average speed of 2.9 kilometers per hour in ice-free waters. It traveled at an average speed of 3.7 kilometers per hour in relative ice-free waters and at an average speed of 2.7 kilometers per hour through eight-tenths ice cover and greater. Another whale traveled 1,291 kilometers at an average speed of 5.13 kilometers in ice-free waters but showed no directed migratory movement, staying within 81 kilometers of the tagging site. Additional tagged whales in 1989 migrated 954-1,347 kilometers at average speeds of 1.5-2.5 kilometers per hour (Wartzog et al., 1990). Mate, Krutzikowsky, and Winsor (2000) tagged 12 juvenile bowhead whales with satellite-monitored radio tags in the Canadian Beaufort Sea. Individual movements and average speeds (1.1-5.8 kilometers per hour) varied widely. The whale with the longest record traveled about 3,886 kilometers from Canada across the Alaskan Beaufort Sea to the Chukchi Sea off Russia and averaged 5.0 kilometers per hour. This whale's speed was faster, though not significantly, in heavy ice than in open water.

Oceanographic conditions can vary during the fall migration from open water to more than nine-tenths ice coverage. The extent of ice cover may influence the timing or duration of the fall migration. Miller, Elliot, and Richardson (1996) observed that whales within the Northstar region (long. 147°-150° W.) migrate closer to shore in light and moderate ice years and farther offshore in heavy ice years, with median distances offshore of 30-40 kilometers (19-25 miles) in both light and moderate ice years and 60-70 kilometers (37-43 miles) in heavy ice years. Moore (2000) looked at bowhead distribution and habitat selection in heavy, moderate, and light ice conditions in data collected during the autumn from 1982-1991. This study concluded that bowhead whales select shallow inner-shelf waters during moderate and light ice conditions and deeper slope habitat in heavy ice conditions. During the summer, bowheads selected continental slope waters and moderate ice conditions (Moore, DeMaster, and Dayton, 2000). Interseasonal depth and ice-cover habitats were significantly different for bowhead whales. Ljungblad et al. (1987) observed during the years from 1979-1986 that the fall migration extended over a longer period, that higher whale densities were estimated, and that daily sighting rates were higher and peaked later in the season in light ice years as compared to heavy ice years.

Fall aerial surveys of bowhead whales in the Alaskan Beaufort Sea have been conducted since 1979 by the Bureau of Land Management and the MMS (Ljungblad et al., 1987; Treacy, 1988-1998; Treacy, 2000). Over a 19-year period (1982-2000), there were 15 years with some level of offshore seismic exploration and/or drilling activity and three blank years (1994, 1995, 1999, and 2000) in which neither offshore activity took place during September or October. The parametric Tukey HSD test was applied to MMS fall aerial-transect data (1982-2000) to compare the distances of bowhead whales north of a normalized coastline in two analysis regions of the Alaskan Beaufort Sea from 140-156° W. longitude (Map 7). While the Tukey HSD indicates significant differences between individual years, it does not compare actual levels of human activity in those years nor does it test for potential effects of sea ice and other oceanographic conditions on bowhead migrations (Treacy, 2000). Treacy (2000) showed in a year-to-year comparison that the mean migration regionwide in fall 1998 was significantly closer to shore in both the East and West Regions than in 1999, a year with no offshore seismic or drilling activity during the fall season in the Alaskan Beaufort Sea.

Treacy (2001) used a Geographic Information System to depict bowhead whale sighting rates by ice severity (Map 8) for the central Alaskan Beaufort Sea (142-155° W. longitudes). During light-ice years, the highest sighting rates of central-area bowhead whales were generally in shallower, nearshore water reflecting coastal contours. During moderate-ice years, central-area whales occurred in mid-range waters, although with some overlap of both light- and heavy-ice categories. During heavy-ice years, central-area whales occupied deeper, offshore waters, with little overlap of whale densities for light-ice years. While other factors may have dominating effects on site-specific distributions, such as prey concentrations, seismic activities, and localized vessel traffic, broad-area fall distributions of bowhead whale sightings in the central Alaskan Beaufort Sea appear to be driven by overall sea-ice severity (Treacy, 2001).

Further evidence that bowhead whales migrate at varying distances from shore in different years is provided by recent site-specific studies monitoring whale distribution relative to local seismic exploration in nearshore waters of the central Beaufort Sea (Miller et al., 1997; Miller, Elliot, and Richardson, 1998; Miller et al., 1999). In 1996, bowhead sightings were fairly broadly distributed between the 10-meter and 50-meter depth contours. In 1997, bowhead sightings were fairly broadly distributed between the 10-meter and 40-meter depth contours, unusually close to shore. In 1998, the bowhead migration corridor generally was farther offshore than in either 1996 or 1997, between the 10-meter and 100-meter depth contours and approximately 10-60 kilometers from shore.

Aerial surveys near the proposed Liberty development project in 1997 (BPXA, 1998a) showed that the primary fall-migration route was offshore of the barrier islands, outside the development area. However, a few bowheads were observed in lagoon entrances between the barrier islands and in the lagoons immediately inside the barrier islands, as shown in Figures 4-4 and 4-5 of the Environmental Report submitted by BPXA for the Liberty development project (BPXA, 1998a). Because survey coverage in the nearshore areas was more intensive than in offshore areas, maps and tabulations of raw sightings overestimate the importance of nearshore areas relative to offshore areas. Transects generally did not extend south of the middle of Stefansson Sound. Nevertheless, these data provide information on the presence of bowhead whales near the proposed Liberty development area during the fall migration. Probably only a small number of bowheads, if any, came within 10 kilometers (6 miles) of the Liberty area.

Some bowheads may swim inside the barrier islands during the fall migration. Frank Long, Jr., reported that whales are seen inside the barrier islands near Cross Island nearly every year and are sometimes seen between Seal Island and West Dock (U.S. Army Corps of Engineers, 1999). Thomas Brower, Sr., from

Barrow, participated in the last commercial whale hunt in 1919. He said that when he went along with the commercial-whale hunts, he saw crews from the whaling ships look for the whales near the barrier islands in the Beaufort Sea and in the lagoons inside the barrier islands (Brower, 1980). Brower also said that whales have been known to migrate south of Cross Island, Reindeer Island, and Argo Island during years when fall storms push ice against the barrier islands. Inupiat whaling crews from Nuiqsut also have noticed that the whale migration appears to be influenced by wind, with whales stopping when the winds are light and, when the wind starts blowing, the whales started moving through Captain Bay towards Cross Island (Tuckle, as cited in USDOI, MMS, 1986b). Some bowhead whales have been observed swimming about 25 yards from the beach shoreline near Point Barrow during the fall migration (Rexford, as cited in USDOI, MMS, 1996c). A comment received from the Alaska Eskimo Whaling Commission on the Liberty draft EIS indicated that Inupiat workers at Endicott have, on occasion, sighted bowheads on the north side of Tern Island, but no source for the reference was provided nor was any specific information provided regarding the location of the whale.

Data are limited on the bowhead fall migration through the Chukchi Sea before the whales move south into the Bering Sea. Bowhead whales commonly are seen from the coast to about 150 kilometers (93 miles) offshore between Point Barrow and Icy Cape, suggesting that most bowheads disperse southwest after passing Point Barrow and cross the central Chukchi Sea near Herald Shoal to the northern coast of the Chukotsk Peninsula. However, scattered sightings north of 72° N. latitude suggest that at least some whales migrate across the Chukchi Sea farther to the north. After moving south through the Chukchi Sea, bowheads pass through the Bering Strait in late October through early November on their way to overwintering areas in the Bering Sea.

Bowheads are filter feeders, filtering prey from the water through baleen fibers in their mouth. Bowheads apparently feed throughout the water column, including bottom or nearbottom feeding as well as surface feeding. Food items most commonly found in the stomachs of harvested bowheads are zooplankton, including euphausiids, copepods, mysids, and amphipods. Euphausiids and copepods are the primary prey species.

The importance of the Alaskan Beaufort Sea as a feeding area for bowheads is an issue of concern to Inupiat whalers. It is likely that bowheads continue to feed opportunistically where food is available as they migrate across the Alaskan Beaufort Sea, similar to what they are thought to do during the spring migration. Some bowheads apparently take their time returning westward during the fall migration, sometimes barely moving at all, with some localities being used as staging areas due to abundant food resources or social reasons (Bodfish, 1981; Akootchook, 1995, as reported in National Marine Fisheries Service, 2001). The Inupiat believe that whales follow the ocean currents carrying food organisms. If the currents go close to Cross Island, whales migrate near there (Napageak, 1996, as reported in National Marine Fisheries Service, 2001). Bowheads have been observed feeding not more than 1,500 feet offshore in about 15-20 feet of water (Brower, 1979; Rexford, 1979, as reported in National Marine Fisheries Service, 2001). Nuiqsut Mayor Nukapigak testified at the Nuiqsut Public Hearing on March 19, 2001, that he harvested a bowhead whale 2 miles from Northstar Island in 1997. He also testified that he and others saw a hundred or so bowhead whales and gray whales feeding near Northstar Island (USDOI, MMS, 2001). Although numerous observations have been made of bowheads feeding during both the spring migration north to the Beaufort Sea and the fall migration west across the Alaskan Beaufort Sea, quantitative data showing how food consumed in the Alaskan Beaufort Sea contributes to the bowhead whale population's overall annual energy needs is fairly limited.

Carroll et al. (1987) and Shelden and Rugh (1995; 2002) report that stomach contents collected from bowheads harvested between St. Lawrence Island and Point Barrow during April into June, indicate some whales feed opportunistically during the spring migration. Carroll et al. (1987) report that the region west of Point Barrow seems to be of particular importance for feeding, at least in some years, but whales may feed opportunistically at other locations in the lead system where oceanographic conditions produce locally abundant food. Shelden and Rugh also suggest the lead system near Point Barrow may serve as an important feeding area in the spring in years when oceanographic conditions are favorable. Lowry (1993) reported that the stomachs of 13 out of 36 spring-migrating bowheads harvested near Point Barrow between 1979 through 1988 contained food. Lowry estimated total volumes of contents in stomachs ranged from less than 1 to 60 liters, with an average of 12.2 liters in eight specimens. The extent or importance of the area to bowheads for feeding is not known, because no estimate of total stomach volume for the whales was provided.

Over the years, bowheads have been reported feeding in the eastern Beaufort Sea and Amundsen Gulf region in Canada and have been observed feeding in various places in the Alaskan Beaufort Sea. Some bowheads appear to feed east of Barter Island as they migrate westward (Thomson and Richardson, 1987). Lowry (1993) reports that stomachs of 13 out of 15 whales harvested off Kaktovik during 1979-1988 contained food, suggesting that nearly all bowheads taken at Kaktovik had been feeding before capture. Lowry estimated total volumes of contents in stomachs ranged from 3-48 liters, with an average of 25.9 liters in eight specimens. One whale was noted as having a full stomach, but no stomach volume was reported. The report did not distinguish between feeding whales with a full stomach and whales with as little as 3 liters of material in the stomach. Stomachs of five out of six whales taken at Point Barrow during 1976-1988 contained food (Lowry, 1993). The total volume of contents of the stomach of one whale was estimated at 109 liters, and three others were estimated at 8 liters. No estimate of total stomach volume for the whales was provided. All whales with food materials in the stomach, regardless of volume, apparently were considered feeding whales.

Lowry and Sheffield (2002) analyzed stomach contents of whales taken at Kaktovik, Cross Island, and Barrow during the fall migration. The standard for a whale being designated as a feeding whale for this study was as little as 10 or more prey items in the stomach. In many instances no information was available about the volume of the stomach contents, but collected samples were available for laboratory analysis.

Twenty-four out of 32 whales taken during the fall at Kaktovik from 1979-2000 and included in this analysis were considered to have been feeding (Lowry and Sheffield, 2002). The status of three other whales was uncertain. Of these 24 known feeding whales, there were estimates of stomach contents for 18 whales. Eleven of the 18 whales had less than 20 liters of material in their stomach, and 7 whales had more than 20 liters of material in their stomach. Several feeding whales had as little as 2-3 liters in the stomach. Two whales had estimated stomach volumes of 136 and 150 liters. Copepods were the dominant prey species by volume.

Four out of five whales taken during the fall at Cross Island from 1976-2000 were considered to have been feeding. Copepods were the main prey in three of the stomachs sampled. The report provided little or no information on volume or stomach content of these whales other than types of prey species.

Seventy-seven out of 106 whales harvested during the fall near Barrow from 1987-2000 and included in this analysis were considered to have been feeding. The status of two other whales was uncertain. There was no estimate of stomach contents for 61 whales. Of the 77 known feeding whales, there were estimates of stomach contents for 16 whales. Seven of the 16 whales had less than 20 liters of material in their stomach, and nine whales had more than 20 liters of material in their stomach. Estimated stomach volumes ranging from 1-189 liters were reported for the 16 whales with stomach contents, with five whales having stomach volumes greater than 100 liters. Euphausiids were the dominant prey species by volume. The extent or importance of the area to bowheads for feeding is not clear from the Lowry and Sheffield 2002 report, because the standard for determining a feeding whale was set so low. As pointed out by Thomson, Koski, and Richardson (2002), there is a large difference between a stomach with that small amount of prey (10 prey items) and one that is full.

Bowheads occasionally have been observed feeding north of Flaxman Island and, in some years, fairly large groups of them have been seen feeding east of Point Barrow between Smith Bay and Point Barrow. Ljungblad et al. (1986) reported that feeding bowheads comprised approximately 25% of the total bowheads observed during aerial surveys conducted in the Beaufort Sea from 1979 through 1985. Miller, Elliott, and Richardson (1998) reported observing many aggregations of feeding whales in nearshore waters near or just offshore of the 10-meter depth contour during late summer/autumn 1997.

Treacy (2002) used a Geographic Information System to identify temporal or spatial patterns in feeding or milling behavior of bowhead whales in a given year or multiple years. Because whales exhibiting milling behavior also may be feeding whales, whales with milling behavior were included with whales with apparent feeding behavior, even though some milling whales were probably engaged in other forms of social behavior. Feeding and milling whales observed per unit effort for each fall season (1982-2001) were mapped for visual comparison of relative occurrence of these behaviors in the Alaskan Beaufort Sea. Treacy (2002) observed a greater relative occurrence of feeding and/or milling behavior of whales on transect in six of the 20 years (1984, 1989, 1997, 1998, 1999, and 2000) near the mouth of Dease Inlet. Greater relative occurrence of feeding and/or milling behavior of bowheads was observed on transect in 4 of those years (1989, 1997, 1998, and 1999) near Cape Halkett. There were 9 other years when feeding and/or milling behaviors were noted on transect at locations other than near Dease Inlet or Cape Halkett (1982, 1983, 1985, 1986, 1988, 1990, 1993, 1995, and 1996). Feeding/milling behaviors during these 9 years were typically spottier, less recurrent between years, and/or involved fewer whales per unit effort. In 5 other years (1987, 1991, 1992, 1994, and 2001), neither feeding nor milling behaviors were observed on transect anywhere in the study area. Interannual and geographic variation in prey availability likely accounts for opportunistic feeding aggregations in particular years and locations (Treacy, 2002).

A study by Richardson (1987) concluded that food consumed in the eastern Beaufort Sea contributed little to the bowhead whale population's annual energy needs, although the area may be important to some individual whales. The conclusion was controversial. The North Slope Borough's Science Advisory Committee (1987) believed there were problems in the study's design and length. The main concerns expressed by the Committee were the short duration of the study (two field seasons, one of which was limited by ice cover), suboptimal sampling designs, and difficulties in estimating food availability and consumption. Two years is too short a period in which to fully characterize the use of an area by bowheads. The Committee also said the overall conclusion of nonimportance seems marginally reasonable only for the whale stock as a whole and only in the context of the sampling period within the 1985-1986 feeding seasons. The Committee did not accept the conclusion that the study area is unimportant as a feeding area for bowhead whales. To respond to these concerns and to better understand the importance of the eastern Alaska Beaufort Sea to bowhead whales, the MMS funded a second study on bowhead whale feeding, entitled *Bowhead Whale Feeding in the Eastern Alaskan Beaufort Sea: Update of Scientific and Traditional Information* (USDOI, MMS, Alaska OCS Region, 1997). The study emphasized cooperation among local government, subsistence-whale hunters, scientists, and MMS in its planning and execution. This bowhead whale-feeding study was an extension of the feeding study conducted in the same area of the eastern Beaufort Sea during 1985 and 1986. The purpose of the project was to compile and integrate existing traditional and scientific knowledge about the importance of the eastern Alaskan Beaufort Sea for feeding by bowhead whales. The study area extended from Flaxman Island to the Alaska/Canada border and from shore to the 200-meter depth contour.

A later study by Koski (2000) summarized that the most common activity of bowheads in the eastern Alaskan Beaufort Sea during late summer and autumn was feeding. Bowhead use of the eastern Alaskan Beaufort Sea during late summer and autumn can be highly variable from year to year, with substantial differences in the numbers, size classes, residence times, and distributions of bowheads recorded there during 1985, 1986, 1998, and 1999.

Following the first year of fieldwork on this study, Griffiths (1999) noted that the average zooplankton biomass in the study area was higher in 1986 than in 1998. Habitat suitable for feeding appears to have been less common in the eastern Alaskan Beaufort Sea in 1998 than it was in 1986. In 1998, the principal feeding area within the eastern study area appeared to have been near Kaktovik.

Griffiths, Thomson, and Bradstreet (2002) discussed zooplankton biomass samples collected in the Canadian Beaufort Sea during the 1980's and in the Alaskan Beaufort Sea in 1986, 1998, and 1999, where bowhead whales were either observed feeding or where whales had been observed feeding the previous day. Bowhead whales feed in areas with a higher than average concentration of zooplankton. The lowest biomass in any of the plankton tows conducted at 17 whale-feeding stations was 545 milligrams per cubic meter. For 4 of the 17 stations the highest biomass measured was 771-807 milligrams per cubic meter, and for 12 of 17 stations the highest value was greater than or equal to 1,000 milligrams per cubic meter. Mean wet-weight biomass in the water column near actively feeding whales was 529 milligrams per cubic meter, a value considerably higher than the mean biomass in the water column elsewhere in the eastern Alaskan and Canadian parts of the Beaufort Sea (230 milligrams per cubic meter). The distribution of biomass values at locations with feeding bowheads indicates that the feeding threshold for bowheads may be a wet biomass of ~800 milligrams per cubic meter.

Bowhead whales moved quickly through the area in 1998 and did not stop to feed for any great period of time. In contrast, during 1986, some individual whales stopped to feed in the study area for periods of at least several days. In 1999, the main bowhead feeding areas were 20-60 kilometers offshore in waters 40-100 meters deep in the central part of the study area east and northeast of Kaktovik, between Kaktovik and Demarcation Bay (Koski, Miller, and Gazey, 2000). In 1999, one bowhead remained in the study area for at least 9 days, and 10 others remained for 1-6 days. Their mean rate of movement was about one-eighth of the rate observed in 1998.

Although various types of evidence (with the exception of isotope ratios) indicate that the eastern Beaufort Sea as a whole, including the Canadian Beaufort, is important to bowhead whales for feeding, the eastern Alaskan Beaufort Sea is only a small fraction of that area (Richardson and Thomson, 2002). The average bowhead does not spend much time in the eastern Alaskan Beaufort Sea and, thus, does not feed there extensively. Koski, et al. (2002) used six calculation methods to estimate residence time for whales in the eastern Alaska Beaufort Sea area, from Flaxman Island to Herschel Island. The annual residence time varied from 2.1-8.3 days and averaged 5.1 days. Richardson and Thomson (2002) estimated that an average bowhead spends ~3.8 days in the area from Flaxman Island to the Alaska/Canada border during late summer/early autumn, or ~1.4 days longer than expected for a whale that swims steadily across that area. Of the individual bowheads that travel through this portion of the eastern Alaskan Beaufort Sea, some spend at least 7 days.

Carbon-isotope analysis of bowhead baleen has indicated that a significant amount of feeding may occur in wintering areas (Schell, Saupe, and Haubenstock, 1987). Baleen from bowhead whales provides a multiyear record of isotope ratios in prey species consumed during different seasons, including information about the occurrence of feeding in the Bering Sea and Chukchi Sea system. Carbon-isotope analysis of zooplankton, bowhead tissues, and bowhead baleen indicates that a significant amount of feeding may occur in areas west of the eastern Alaskan Beaufort Sea, at least by subadult whales (Schell, Saupe, and Haubenstock, 1987). The isotopic composition of the whale is compared with the isotope ratios of its prey from various geographic locations to make estimates of the importance of the habitat as a feeding area. Subadult whales show marked changes in the carbon isotope over the seasons, indicating that carbon in the body tissues is replaced to a large extent from feeding in summer and feeding in the autumn-winter months. In contrast, adult animals sampled show very little seasonal change in the carbon isotope and have an isotopic composition best matched by prey from the western and southern regions of their range, implying that little feeding occurs in summer (Schell and Saupe, 1993).

The isotopic data also indicate that primary productivity in the Bering and southern Chukchi seas is declining. Schell (1999a) looked at baleen from 35 bowheads that were archived, in addition to whales from the recent harvest, and constructed an isotopic record that extends from 1947-1997. He inferred from this record that seasonal primary productivity in the North Pacific was higher over the period from 1947-1966, and then began a decline that continues to the most recent samples from 1997. Isotope ratios in 1997 are the lowest in 50 years and indicate a decline in the Bering Sea productivity of 35-40% from the carrying capacity that existed 30 years ago. If the decline in productivity continues, the relative importance of the eastern Beaufort Sea to feeding bowheads may increase (Schell, 1999b).

Lee and Schell (2002) analyzed carbon isotope ratios in bowhead whale muscle, baleen, and fat, and in bowhead food organisms. The isotopic signatures in zooplankton from Bering and Chukchi waters, which sometimes extend into the western Beaufort Sea, are similar and cannot be differentiated from one another. Zooplankton from the eastern Beaufort Sea (summer and early autumn range) has an isotopic signature that is distinct from that in Bering/Chukchi zooplankton. Lee and Schell compared these isotopic signatures in zooplankton to isotopic signatures in bowhead tissues.

Lee and Schell (2002) found that carbon isotopes in the muscle sampled in the fall were not significantly different from those in muscle sampled in the spring. Carbon isotopes in the muscle during both seasons closely matched the isotope ratios of zooplankton from the Bering and Chukchi waters, indicating most of the annual food requirements of adults and subadults are met from that portion of their range. Based on the comparison of carbon isotopes in the zooplankton and in bowhead tissues, they estimate that 10-26% of the annual bowhead feeding activity was in the eastern and central Beaufort Sea waters, roughly east of Prudhoe Bay.

Isotope data from baleen showed different feeding strategies by adult and subadult whales. Subadults acquired sufficient food in the eastern Beaufort Sea to alter the carbon isotope ratios in baleen relative to baleen representing feeding in Bering and Chukchi waters. Baleen plates from subadults showed a wider range in isotope ratios than those from adults, suggesting active feeding over all parts of their range.

A study by Hoekstra et al. (2002) concluded that seasonal fluctuations in carbon isotope values was consistent for all age classes of bowhead whales and suggests that the Bering and Beaufort Seas are both important regions for feeding. Hoekstra et al. (2002) included data on isotope ratios in tissue subsamples from some of the same individual bowheads from Kaktovik and Barrow that were analyzed by Lee and Schell. There was an apparent discrepancy in the data from these two studies and somewhat different conclusions. The source of the discrepancy related to differences in the results from the Kaktovik whale muscle samples. Hoekstra et al. (2002) suggest the percentage of annual feeding activity in the eastern Beaufort Sea could be on the order of 37-45% (compared to 10-26%). This discrepancy was considered critical in assessing the importance of feeding in the eastern Beaufort Sea. Lee and Schell subsequently repeated their isotopic analyses on additional subsamples from the same Kaktovik whales and obtained the same results they obtained initially (Lee and Schell, 2002). These re-analyses confirm the accuracy of the measurements reported by Lee and Schell in their draft report. Hoekstra et al. have not repeated their isotopic analyses at this time; therefore, the reason for the discrepancy between the two sets of data remains uncertain.

Estimated food consumption by bowheads in the eastern Alaskan study area (Flaxman Island to Alaska/Canada border) was expressed as a percentage of total annual consumption by the population (Thomson, Koski, and Richardson, 2002). This was done separately for each year of the study and averaged for the 5 years of the study. Based on this approach, in an average year the population of bowhead whales is estimated to consume about 2.4% of its annual energetic requirements in the study area. In 1 of the 5 years (1999), the population of bowheads may have derived about 7.5% of annual energetic requirements in the study area. In all other years, estimated consumption in the study area was less than 2%.

Thomson, Koski, and Richardson (2002) tried to reconcile the low estimates of summer feeding, as evident from the isotope data of Lee and Schell, with other data: behavioral observations showing frequent feeding in the eastern Beaufort Sea during the summer and early autumn; zooplankton sampling near bowheads feeding in those areas shows that whales concentrate their feeding at locations with much higher than average biomasses of zooplankton; frequent occurrence of food in the stomachs of bowheads harvested in the Alaskan Beaufort Sea during late summer and autumn; and length-girth relationships show that subadult bowheads, and possibly adults, gain weight while in the Beaufort Sea in summer and lose weight while elsewhere and lipid content of blubber, at least in subadults, is higher when they leave the Beaufort in fall than when they return in spring. Although some of this evidence suggests the importance of feeding in the Beaufort Sea during summer and early autumn, those types of data on summer and early fall feeding in the Beaufort Sea do not specifically show what fraction of the annual feeding occurs in the eastern and central Beaufort Sea. No comparable data on feeding, girth, or energy content have been obtained during and after the whales feed in the Chukchi sea in mid- to late fall. Perhaps, more feeding and energy accumulation occurs there in fall than in the Beaufort Sea in summer. If so, the observations of feeding in the Beaufort Sea might not be inconsistent with the strong Bering/Chukchi isotope signature in bowhead tissues.

Thomson, Koski, and Richardson (2002) offered a feeding scenario that might be consistent with all these data: feeding occurs commonly in the Beaufort Sea in summer and early autumn, and bowheads gain energy stores while feeding there. However, zooplankton availability is not as high in the Beaufort Sea during summer as in the Chukchi and northern Bering seas during autumn. Also, feeding in the western Beaufort in autumn effectively may be on Chukchi prey advected to that area. Thus, bowheads might acquire more energy from Bering/Chukchi prey in autumn than from eastern and central Beaufort prey in summer/early autumn. Given this, plus an assumed low turnover rate of body components, the overall body composition of bowheads may be dominated by components from the Bering/Chukchi system, even at the end of the summer when leaving the Beaufort. Energy gained in the Beaufort and Chukchi seas during summer and fall presumably is used during winter when food availability is low, resulting in reduced girth and energy stores when returning to the Beaufort Sea in spring than when leaving in autumn. Several aspects of this scenario are speculative.

Richardson and Thomson (2002) summarized the information from the bowhead whale feeding study:

- A comparison of carbon isotope ratios in bowhead muscle and baleen with those in the main food organisms suggests that bowhead whales consume only a minority of their food in the eastern and central Beaufort Sea, including the Canadian and the eastern Alaskan Beaufort Sea. Based on stable-isotope evidence, bowhead whales likely consume only 10-26% of their food in the eastern and central Beaufort Sea. Subadult bowheads appear to derive greater than 10% of annual food requirements there, although the 95% confidence interval extends below 10%. It also is probable that adults gain greater than10% of their food in that area but, for adults, the isotope evidence considered in isolation would support an answer of less than 10%.
- An average bowhead spends ~3.8 days in the area from Flaxman Island to the Alaska/Canada border during the late summer/autumn period, or ~1.4 days longer than expected for a whale that swims steadily across that area. Averages in various years ranged from ~2.5-6.3 days. Although the average was less than 7 days in all years studied, it might exceed 7 days in a small minority of the years, based on the calculated upper 95% confidence bounds. Of the individual bowheads that travel through the eastern Alaskan Beaufort Sea, some spend at least 7 days between the Alaska/Canada border and Flaxman Island during late summer and autumn.
- The percentage of the study area suitable as feeding habitat, i.e., with 800 milligrams per cubic meter zooplankton at some depth, averaged 25% over 4 years with effective echosounder sampling, and varied from 7-43% in individual years.
- Based on stomach content data supplemented by behavioral evidence, far more than 10% of the bowheads that pass through the eastern Alaskan Beaufort Sea during late summer and autumn feed there. Of the whales harvested at Kaktovik, 24 out of 32 whales had been feeding. The status of three other whales was uncertain. Of the 24 feeding whales, there were estimates of stomach contents for 18 whales. Eleven of these 18 whales had less than 20 liters of stomach contents and 7 whales out of the 18 had 20 liters or more of stomach contents.
- Bowheads fed for an average of 47% of their time in the eastern Alaskan Beaufort Sea during late summer and autumn. A substantial minority of the feeding occurred during travel. Among traveling whales, feeding as well as travel was occurring during a substantial percentage of the time, on the order of 43%.
- In an average year, the population of bowhead whales derives an estimated 2.4% of annual energetic requirements in the eastern Alaskan Beaufort Sea. In 1 of 5 years of study, the population may have derived as much as 7.5% of annual energetic requirements from the area. Use of the study area varies widely in time and space, depending on zooplankton availability and other factors.

Information regarding age at sexual maturity or mating behavior and timing for bowhead whales is not known with certainty. Most bowheads mate and calve from April through mid-June, coinciding with the spring migration. Mating may start as early as January and February, when most of the population is in the Bering Sea, but mating also has been reported as late as September and early October (Koski et al., 1993). Calving occurs from March to early August, with the peak probably occurring during the spring migration between early April and the end of May (Koski et al., 1993). Females give birth to a single calf probably every 3-4 years.

Reese et al. (2001) developed a nonlinear model for fetal growth in bowhead whales to estimate the length of gestation, with the model indicating an average length of gestation of 13.9 months. By comparison, the length of gestation for bowhead whales was estimated to be between 13 and 14 months by Nerini et al. (1984, as reported in Reese et al., 2001) and between 12 and 16 months by Koski et al. (1993). The model by Reese et al. (2001) also indicated that conception likely occurs in early March to early April, suggesting that breeding occurs in the Bering Sea. The conception date and length of gestation suggests that parturition is likely to occur in mid-May to mid-June, when most whales are between the Bering Strait and Point Barrow. Reese et al. (2001) said this is consistent with other observations in the region, including: (a) relatively few neonate-cow pairs are reported by whalers at St. Lawrence Island; (b) many neonates are seen during the whale census in late May; (c) relatively few term females have been taken at Barrow; (d) females with term pregnancies appeared close to parturition; and (e) most of the herd is believed to have migrated past Barrow by late May.

Several researchers have explored techniques for aging bowheads, including tympanic bullae lamina, carbon isotopes in baleen, photographic recapture, and aspartic-acid racemization of the eye lens. The various approaches at aging bowhead whales and estimating survival rates all suggest slow growth, great longevity, and high survival rates. Schell and Saupe (1993) looked at baleen plates as a means to determine the age of bowhead whales and concluded that bowheads are slow-growing, taking about 20 years to reach breeding size. Zeh et al. (1993), while looking at population structure and dynamics, also concluded that the bowhead is a late-maturing, long-lived animal with fairly low mortality. Photographic recaptures by Koski et al. (1993) also suggested advanced age at sexual maturity of late teens to mid-twenties. Most female bowheads become sexually mature when they are 12.5-14.0 meters long, probably at an age exceeding 15 years. The discovery of traditional whaling tools recovered from five bowheads landed since 1981 also suggest advanced longevity (George et al., 1995), in some instances exceeding 100 years. George et al. (1999), using the aspartic-acid racemization techniques, estimated the age of 42 whales. The results indicated that four animals exceeded 100 years of age.

There is little information regarding natural mortality for bowhead whales in the Bering, Chukchi, and Beaufort seas. Bowhead whales have no known predators except, perhaps, killer whales and subsistence whalers. Attacks by killer whales have occurred, but the frequency probably is low. George et al. (1994) concluded that the relatively low frequency of bite marks likely reflects a relatively low frequency of killer whale attacks and predation pressure. Likewise, the scarcity of observations of vessel-inflicted injuries suggests that the incidence of ship collisions with bowhead whales also is quite low. There also are some reports of bowheads becoming entangled in ropes from crab pots, harpoon lines, or fishing nets; however, the frequency of occurrence is not known. Some whales likely die as a result of entrapment in ice, but the number is thought to be relatively small (Philo et al., 1993). Little is known about the effects of microbial or viral agents on natural mortality.

III.B.4.a(2) Spectacled and Steller's Eiders

III.B.4.a(2)(a) Population Status and Spring Migration

An estimated 7,370 spectacled eiders occupied the Arctic Coastal Plain of Alaska in June 2001 (Larned et al., 2001), about 2% of the estimated 363,000 world population (USDOI, Fish and Wildlife Service, 1999). Nonbreeders, assumed to remain at sea in summer, are not included in the Alaska estimate. The arctic Alaska population has shown a nonsignificant decreasing trend from 1993-2000 (Larned et al., 2001). Details of population status and annual cycle may be found in the final EIS's for Liberty and Sale 170 (USDOI, MMS, Alaska OCS Region, 2002a; USDOI, MMS, 1998); the National Petroleum Reserve-Alaska Integrated Activity Plan EIS (USDOI, Bureau of Land Management and MMS, 1998); Petersen, Grand, and Dau (2000); Troy Ecological Research Assocs. (1999); and USDOI, Fish and Wildlife Service (1999). The spectacled eider was listed as a threatened species under the Endangered Species Act in May 1993.

The only known wintering area lies south of St. Lawrence Island in the Bering Sea. Because few eiders are observed in marine areas along the Beaufort coast in spring, a majority may migrate to the nesting areas overland from the Chukchi Sea (Troy Ecological Research Assocs., 1999).

III.B.4.a(2)(b) Nesting and Postnesting Periods

Spectacled eider nests are widely separated, nesting mainly from the Sagavanirktok River to the Chukchi Sea, and only sparsely to the east (Larned et al., 2001). The highest densities determined from Fish and Wildlife Service aerial surveys for eiders in 1998-2001 on the Arctic Coastal Plain east to the Arctic National Wildlife Refuge were found south of Barrow, with smaller areas east of Teshekpuk Lake, on the Colville River Delta, and near western Simpson Lagoon (Map 9a). Overall density was determined as 0.24 birds per square kilometer (304 birds observed) in 2001 (Larned, et al., 2001).

Following their early (June) departure from the nesting areas, males apparently make relatively little use of the Beaufort before migrating to the Chukchi Sea. A few satellite-tagged males have been located in western Simpson Lagoon and Harrison Bay (Map 9b). Females that have not nested, or had nest failure, may occur in Beaufort Sea waters from late June through August. Females with broods are present from late August. The use of Beaufort coastal waters by females is more widespread than males, but Harrison

Bay also is used frequently, as suggested by locations of birds by satellite telemetry (Map 9b). Apparently, there is considerable variation in the speed of movement from east to west across the Beaufort Sea by individual birds, as indicated by successive locations of specific satellite transmitters (numbers near map symbols). From the Prudhoe Bay area, where birds were equipped with transmitters that broadcast a location every 3 days, some birds left the Beaufort Sea before the next location was broadcast (for example, males 7347, 7353). Others were recorded at intermediate points for 1-3 three-day intervals before departing the map area (males 7352, 7354; females 4453, 4457, 4500, 7339, 7341, 7356, 7362). It does not appear that any birds remained in the Beaufort more than 9 days after receiving a transmitter, and most departed more quickly.

Aerial surveys in the central Beaufort Sea area from Harrison Bay/Cape Halkett to Mikkelsen Bay/Brownlow Point in 1999 and 2000 by the Fish and Wildlife Service located 148 individuals in offshore waters; 147 of these were in deeper waters (greater than 10 meters) of Harrison Bay, including one large flock of 100 birds (Fischer, Tiplady, and Larned, 2002; Map 9a). A Fish and Wildlife Service survey from Point Barrow to Demarcation Point in 2001 located 15 individuals off western Simpson Lagoon, in outer Smith Bay, and off the Plover Islands east of Point Barrow (Fischer, 2001; Map 9a). It should be noted that aerial flight lines along which birds were counted during 1999 and 2000 surveys were separated by only 5.4 kilometers and confined to the area between Harrison Bay/Cape Halkett to Mikkelsen Bay/Brownlow Point, compared to 10 kilometers in the 2001 survey, which covered the entire Alaskan Beaufort Sea coast from Point Barrow to Demarcation Point and, thus, lines along which birds are plotted are closer together and almost twice as numerous in the central area as to the east and west.

III.B.4.a(2)(c) Steller's Eider

Recent surveys have found very low densities (0.01 birds per square kilometer, Larned, et al., 2001) of this species on the western Arctic Coastal Plain as far east as the Colville River Delta (Map 9b). It is rare in this latter area and extremely rare farther east (Larned, et al., 2001; Mallek, 2001; Mallek, Platte, and Stehn, 2002). The estimated coastal plain population is about 1,000 individuals; its center of abundance and nesting is the Barrow area (USDOI, Fish and Wildlife Service, 1999), with a high density of 0.08 birds per square kilometer (44-112 birds observed in 1999-2001) determined by intensive surveys in this area (Ritchie and King, 2001). Nesting does not occur every year in this area, possibly related to predator presence (Quakenbush and Suydam, 1999). Although Dau and Anderson (2001) did not observe Steller's eiders during their Beaufort Sea nearshore-barrier island aerial survey in late June-early July 2001, Fischer (2001) observed three near Cape Simpson in Smith Bay during transects flown in late July 2001. The Alaska population of the Steller's eider was listed as threatened under the Endangered Species Act in June 1997.

III.B.4.a(2)(d) Critical Habitat

Critical habitat for these eiders was designated in February 2001. Spectacled eider areas include Ledyard Bay in the southeast Chukchi Sea, the wintering area south of St. Lawrence Island, Norton Sound, and the Yukon-Kuskokwim Delta. Critical habitat for the Steller's eider includes the Yukon-Kuskokwim Delta and four areas of southwest Alaska.

III.B.5. Marine and Coastal Birds

Several million birds of about 70 species occur regularly in Arctic Coastal Plain and Beaufort Sea habitats in or adjacent to the multiple-sale area (BPXA, 1995, 1998a; Johnson and Herter, 1989; USDOI, MMS, 1996a, 1998; Troy Ecological Research Assocs., 1993, 1995b). Nearly all are migratory, present for all or part of the period May to early November. A majority of species found in coastal areas are waterfowl or shorebirds; other groups represented by one or more species that also are fairly common to abundant include loons, seabirds, hawks/eagles, ptarmigan, and songbirds. Aerial surveys in the Beaufort Sea have documented that birds are widespread in substantial numbers in both nearshore and offshore waters of this area (Fischer, 2001; Fischer, Tiplady, and Larned, 2002; Larned, Platte, and Stehn, 2001; Stehn and Platte, 2000; USDOI, Fish and Wildlife Service, 2002) and it is likely that approximately this distribution prevails along most or all of the Beaufort coastline and into the northern Chukchi Sea during the open-water season.

Birds occur out to at least 70 kilometers offshore where open water is available. Important features of various species' annual cycle events, habitats, abundance, and population status are summarized below; details of these topics may be found in the final EIS's for Liberty and Sale 170 (USDOI, MMS, Alaska OCS Region, 2002a; USDOI, MMS, 1998) and the Northwest National Petroleum Reserve-Alaska Integrated Activity Plan EIS (USDOI, Bureau of Land Management and MMS, 2002).

III.B.5.a. Annual Cycle

III.B.5.a(1) Spring Migration

Waterfowl species such as the **long-tailed duck**, **king eider**, **common eider**, and **brant** migrate eastward along a broad front, which may include inland, coastal, and offshore routes, from about early May to mid-June (Johnson and Herter, 1989; Johnson and Richardson, 1982; Richardson and Johnson, 1981). A substantial proportion of several species' Pacific breeding population passes through or adjacent to the multiple-sale area during spring migration. The availability of open water off river deltas and in leads determines migratory routes and distribution of loons, waterfowl, and seabirds at this time. These areas are occupied until local nesting areas are free of snow in June (Bergman et al., 1977; Johnson and Herter, 1989). Most **shorebirds** and other **waterfowl** concentrate in snow-free coastal or inland areas until nest sites are available. For example, in early to mid-June prebreeding shorebirds such as sanderlings, Baird's sandpiper, and semi-palmated plover occur on early-opening gravel and mud areas on some beaches and pools. Arrival dates for various species range from late April to early June.

III.B.5.a(2) Nesting Period

Islands in river deltas and barrier islands provide the principal nesting habitat for several waterfowl and marine bird species in the Beaufort Sea region. In particular, **lesser snow geese** and **brant** nest on Howe and Duck islands in the Sagavanirktok River Delta (Johnson, 1994a,b; Stickney and Ritchie, 1996); snow geese also nest on the Ikpikpuk River delta at Smith Bay (Ritchie, Lovely, and Knoche, 2002), apparently increasing from about 100 nesting pairs in 1998 (Ritchie, Burgess, and Suydam, 2000) to more than 800 pairs in 2002 (Suydam, 2002, pers. commun., as cited in North Slope Borough, 2002:letter comment on Beaufort Sea Planning Area EIS). Up to 7,500 snow geese nest on the Kendall Island Bird Sanctuary on the Mackenzie River delta. Large numbers of **brant** and other goose species often occur in the Teshekpuk Lake Special Area , especially on lakes between Teshekpuk and the coast. Scattered colonies of brant occur through northwest Alaska, particularly from Smith Bay west to the Chukchi coast, and low numbers southward to Kasegaluk Lagoon (Ritchie, Lovely, and Knoche, 2002). **Common eiders**, **glaucous gulls,** and **arctic terns** nest on barrier islands in the east-central Beaufort Sea in addition to on other islands and causeways (Flint, et al., 2000; Johnson, Wiggins, and Rodrigues, 1993; Johnson and Herter, 1989; Schamel, 1978; Maps 10a, 11a). Terns also nest at high density inland across much of the Arctic Coastal Plain, and **common eiders** have been documented nesting on the mainland near Point Thomson (U.S. Geological Survey, Biological Resources Div., 2002, pers. commun.). **Common eider** young may occur in creches of varying size, particularly where eiders nest in colonies (Flint, et al., 2000; Johnson and Herter, 1989). **Black guillemots** nest mainly on barrier islands in the western Beaufort, particularly Cooper Island (Divoky, Watson, and Bartonek, 1974).

Pacific loons; tundra swans; greater white-fronted geese; several **duck species** including the abundant **northern pintail; shorebirds (**Map 10a**), jaegers; glaucous gulls;** and **arctic terns** nest across most of the Arctic Coastal Plain, generally at higher densities west of the Prudhoe Bay area; but they also extend into northern Canada in smaller numbers. **Sabine's gull** occurs mainly from the Deadhorse area west; it is an uncommon breeder in the Arctic National Wildlife Refuge. **Shorebirds** are numerically dominant in most coastal plain bird communities (Map 10a), occurring across northern Alaska, including the Arctic National Wildlife Refuge, and Canada, including Kendall Island Bird Sanctuary, using a range of habitats from dry gravelly to wet tundra and littoral. Members of this group, including dunlin, semi-palmated sandpiper, and American golden-plover, also nest on barrier islands which have tundra habitats, as do several passerine species including Lapland longspur, redpoll, and snow bunting (U.S. Geological Survey, Biological Resources Div. 2002, pers. commun.). Shorebirds likely to nest in these habitats also include semi-palmated plover, pectoral sandpiper, red-necked phalarope, and red phalarope. Concentrations of **Canada**

geese occur in the Teshekpuk Lake area and at lower density in the Prudhoe Bay region. **Long-tailed ducks** are widespread in northern Alaska, including the Arctic National Wildlife Refuge, and Canada (Map 10b). Probably three-quarters of Beaufort Sea **king eiders** occupy western Canada and northeastern Alaska during the breeding season (Dickson et al., 1997; Suydam, 2000). Other areas of relatively moderate density occur on the coastal plain from west of Prudhoe Bay to south of Barrow (Larned, Platte, and Stehn, 2001; Map 11a). **Yellow-billed** and **red-throated loons** (Gotthardt, 2001) nest mainly south and west of Smith Bay.

III.B.5.a(3) Postnesting Period

Most broodrearing and/or molting **loons, swans**, and **geese** occur in large lakes. B**rant** molt on lakes in the Teshekpuk Lake area or lakes near their nesting colonies elsewhere. In addition, postmolting and broodrearing **brant** use various coastal habitats such as sloughs and tidal flats (Derksen, Bollinger, and Esler, 1992; Johnson and Herter, 1989; Ritchie, Lovely, and Knoche, 2002) from early July through August. Major concentrations of molting waterfowl occur in several areas along the Beaufort and Chukchi sea coasts including Simpson Lagoon, the Teshekpuk Lake Special Area, Peard Bay, Kasegaluk Lagoon, and Ledyard Bay from late June through August. Teshekpuk Lake is the most important molting location for **brant**, especially failed breeders and nonbreeders from western Alaska and the Yukon-Kuskokwim Delta, Canada, and Siberia beginning in late June; substantial numbers **of greater white-fronted** and **Canada geese** also molt in this area. Numbers occupying the area during the molt period vary considerably, from low thousands to tens of thousands of individuals, in part depending on greater or lesser nest success by the various species (Mallek, 2001; Mallek, Platte, and Stehn, 2002). **Snow goose** broodrearing occurs in Foggy Island Bay and surrounding river deltas (Johnson, 1998).

Large numbers of **long-tailed ducks** molt in Simpson and other Beaufort lagoons and bays beginning in mid-July (Johnson, 1984; Johnson and Gazey, 1992; Lanctot et al., 2001; Map 10b). (Note that the apparently higher offshore bird densities recorded during aerial surveys confined to the central Beaufort Sea region from Harrison Bay/Cape Halkett to Mikkelsen Bay/Brownlow Point in 2000, compared to those recorded in areas farther east or west during aerial surveys that covered the entire Alaskan Beaufort coast from Point Barrow to Demarcation Point, may be partly an artifact of sampling intensity. This is because aerial survey flight lines along which birds were counted were separated by only 5.4 kilometers in the central survey area, compared to 10 kilometers in areas farther east or west and, thus, lines along which birds are plotted are closer together and almost twice as numerous in the central area as in the eastern or western areas). Most birds are located along barrier islands or in lagoons rather than seaward from lagoons or along mainland shores (Flint et al., 2000). To a considerable extent, molting and staging individuals remain in the same area of a particular lagoon during their stay in the Beaufort region (Flint et al., 2000). Males and nonbreeders/failed breeders are joined later by females with young.

Males and nonbreeding or failed breeding female **common eiders** migrate to coastal molting areas in Chukchi Sea lagoons and bays beginning in late June and early July (Johnson and Herter, 1989; Map 11b). Some females with young may molt in local coastal lagoons (Barry, 1968; Johnson and Herter, 1989) before moving south to wintering areas beginning in late August and continuing into early November. Male **king eiders** undertake a molt migration to Chukchi and Bering sea areas from early July through August (Dickson, Suydam, and Balogh, 2000; Maps 11a and 11b). Apparently, some molt in the Beaufort Sea (Suydam et al., 1997). Females migrate from mid-August into September, and young leave the breeding areas in September and October. These species, together with the long-tailed duck, are common migrants along the coast of the Arctic National Wildlife Refuge.

Along the Beaufort coastline, nonincubating members of **shorebird** pairs concentrate in coastal habitats as early as mid-June. In late June to early July, individuals and flocks of nonbreeding and postbreeding adults of several species move to habitats surrounding small coastal lagoons and nearby brackish pools. In late July and early August, adults relieved of parental duties flock in shoreline areas prior to migration. In August and September, juvenile semi-palmated sandpipers and red phalaropes feed along inner lagoon margins in preparation for migration. Shoreline use by red phalaropes in particular is extensive, with concentrations exceeding 500 per kilometer of gravel beach reported on the Barrow spit and in the Simpson Lagoon area (U.S. Geological Survey, Biological Resources Div., 2002, pers. commun.). Parents with fledged young follow in several weeks, and juveniles form large flocks in mid- to late August (Johnson and Richardson, 1981). Most have departed the area by mid-September.

III.B.5.b. Habitat Use and Abundance

In the Beaufort Sea region, most loons, waterfowl, and seabirds are found within 50 kilometers of the coast (Map 10a). (Note that the apparently higher offshore bird densities recorded during aerial surveys confined to the central Beaufort Sea region, from Harrison Bay/Cape Halkett to Mikkelsen Bay/Brownlow Point in 2000, compared to those recorded in areas farther east or west during aerial surveys that covered the entire Alaskan Beaufort coast from Point Barrow to Demarcation Point, may be partly an artifact of sampling intensity. This is because aerial survey flight lines along which birds were counted were separated by only 5.4 kilometers in the central survey area, compared to 10 kilometers in areas farther east or west and, thus, lines along which birds are plotted are closer together and almost twice as numerous in the central area as in the eastern or western areas). Bird densities generally are lower in offshore areas. In nearshore marine areas, barrier islands provide important nesting habitat for **common eiders**, **glaucous gulls**, **arctic terns**, and **black guillemots**. Many species may return to the same areas for nesting in successive years (for example, **common eider**, Map 11b). The Teshekpuk Lake Special Area and the Colville River; Sagavanirktok, Canning, and Hulahula river deltas; and the Arctic National Wildlife Refuge provide important nesting habitat for **loons**, **waterfowl**, and **shorebirds** (Map 10a). Large numbers of several goose populations from Canada, Russia, and elsewhere in Alaska molt in the Teshekpuk Lake Special Area, which apparently is preferred because of the presence of large lake basins that provide extensive meadows of high-quality forage conveniently located in a coastal area.

Shorebirds prefer wet-tundra habitats (**sandpipers, phalaropes**) or well-drained gravelly areas (**plovers**) for nesting, whereas **loons** use lakes, and geese prefer deeper ponds (**brant**) or wet tundra near lakes (**greater white-fronted goose**). **Long-tailed ducks** (Map 10b) nest on small ponds with some deeper water and **king eiders** (Map 11a) prefer ponds with extensive deeper areas. The highest nesting densities generally occur in areas of mixed wet and dry habitats, whereas birds often move to wetter areas for broodrearing. Lagoons formed by barrier islands, bays, and river deltas provide important broodrearing and staging habitat for waterfowl, particularly molting **long-tailed ducks,** and staging habitat for this species; **eiders;** other waterfowl species (Maps 10a, 10b, 11b); and **plovers, sandpipers,** and **phalaropes**. Flocks of nonbreeding and postbreeding adults of several shorebird species move from wet tundra to habitats surrounding small coastal lagoons and nearby brackish pools. Later on, adults relieved of parental duties flock in shoreline areas, and juvenile semi-palmated sandpipers and red phalaropes feed along inner lagoon margins prior to migration. Gravel beach and other shoreline types are used extensively by red phalaropes at this time. Use of lagoons and other coastal habitats by migrants peaks in August to late September. From late September to mid-October, a majority of the world **Ross' gull** population occurs offshore of Point Barrow and eastward to the Plover Islands (Divoky, Hatch, and Haney, 1988).

Aerial surveys over the Arctic Coastal Plain have shown that most waterfowl and other waterbird species have exhibited nonsignificant population trends since 1986 or 1992 (Larned and Balogh, 1997; Larned et al., 1999; Larned, Platte, and Stehn, 2001; Mallek and King, 2000; Mallek, Platte, and Stehn, 2002), although there is conflicting evidence for some species. For example, during a recent spring migration an estimated 373,000 **king eiders** (see the following estimates derived from offshore aerial surveys) and 71,000 **common eiders** passed Point Barrow (Suydam et al., 1997, 2000); these numbers represent declines of 53% and 56%, respectively, from the 1970's. However, recent aerial breeding-pair surveys show a slightly increasing trend for **king eiders** on the coastal plain (Larned et al., 2001), and these surveys do not include some areas with highest nesting densities (for example, northwest Canada). Even though their populations are reduced from prior decades, these eiders still occur in flocks of substantial size during spring and fall migration periods. **Pacific loons**, **glaucous gulls**, **northern pintails**, **greater scaup**, **white-winged scoters**, **brant**, **snow geese**, and **tundra swans** have exhibited overall non-significant increasing trends since 1992, while **yellow-billed loons**, **Canada goose**, and **snowy owls** show decreases (Larned, et al., 2001; Mallek, Platte, and Stehn, 2002). **Greater white-fronted geese** and **arctic terns** increased significantly. The results of the two surveys cited, flown about mid-June and late June, indicate opposite trends for several species over the past 10-15 years: the earlier survey (Larned) shows **red-throated loons** decreasing significantly, **Sabines's gulls** decreasing, and **long-tailed ducks** and **jaegers** increasing; while the later survey (Mallek) indicates the reverse. Such differences probably are explained by a combination of variation in bird detection (for example, different observers used between years and change to more secretive behavior as the season progresses for some species) and real timing differences in bird presence during sampling periods separated by up to 2 weeks.

Recent Fish and Wildlife Service estimates of **long-tailed ducks** occupying the central Beaufort Sea area (Harrison Bay/Cape Halkett to Mikkelsen Bay/Brownlow Point) during surveys up to 60 kilometers offshore ranged from 20,994 in June/July to 37,792 in August, with densities ranging from 58.1-73.8 birds per square kilometer (Fischer, Tiplady, and Larned, 2002; Stehn and Platte, 2000). Numbers of **king eider** were 19,842 (June/July) and 6,698 (August), with densities from 3.6 (June/July) to 10.0 (August) birds per square kilometer; **common eider** numbers were 3,300 (June/July) and 1,477 (August), with densities from 4.6 (June/July) to 56.4 (August) birds per square kilometer. Generally, fewer than 1,000 **Pacific loons**, 200 **red-throated loons**, and 100 **yellow-billed loons** were present in this area at very low densities. Offshore aerial surveys by the Fish and Wildlife Service in late July 2001, spanning the Beaufort from Point Barrow to Demarcation Point (Fischer, 2001), suggest that offshore bird distributions across this broad area generally are similar to those found in the more extensively surveyed central area. An exception from 1999 and 2000 central Beaufort aerial survey results was noted for **king eiders**, which were found farther offshore and almost exclusively west of Harrison Bay (Map 11a). Neither survey recorded this species over a broad area from east of Mikkelsen Bay to the Canadian border. Possible explanations for this include that the survey timing missed the bulk of migrants (unlikely, because they were abundant to the west); or that eiders migrating from Canadian islands follow a route that takes them farther offshore than the northernmost extent of the aerial survey transects until they reach the central Beaufort region and so they were not observed.

The highest breeding-season densities for 34 species in an area east of Prudhoe Bay ranged from 251.7 birds per square kilometer in the second week of June to 167.0 in mid-July, and 131.7 in mid-August. Most abundant were **Lapland longspurs** and several shorebird species (Troy Ecological Research Assocs., 1995b).

III.B.6. Marine Mammals (Pinnipeds, Polar Bears, and Beluga and Gray Whales)

This discussion emphasizes species of marine mammals other than endangered whales commonly occurring in the Alaskan Beaufort Sea habitats that may be affected by the proposed sale. Species covered include the ringed, bearded, and spotted seal and the walrus, polar bear, and beluga and gray whales. Other species that are uncommon or rare in the sale area but that occasionally occur in small numbers (fewer than 100 to fewer than 10) include the harbor porpoise, killer whale, narwhal, and hooded seal. Because of the relative numerical insignificance of the latter species in the Beaufort Sea Planning Area (fewer than 100 to fewer than 10 individuals of any of these species have been recorded in the Beaufort Sea), their populations are not expected to be exposed to or be affected by any activities associated with the Proposal and, therefore, are not discussed further.

All marine mammals in U.S. waters are protected under the Marine Mammal Protection Act of 1972. In the act, it was the declared intent of Congress that marine mammals “be protected and encouraged to develop to the greatest extent feasible commensurate with sound policies of resource management, and that the primary objective of their management should be to maintain the health and stability of the marine ecosystem.”

III.B.6.a. Ringed Seal

Widely distributed throughout the Arctic, this species is the most abundant seal in the Beaufort Sea. The estimated population in the Alaskan Beaufort Sea was 80,000 during the summer and 40,000 during the winter (Frost and Lowry, 1981). There currently is no reliable estimate for the Alaskan stock of ringed seals, but there is no reason to believe that the minimum abundance is below 50,000 animals (Ferrero et al., 2000). Ringed seal densities within the Beaufort Sea depend on food availability, water depth, ice stability, and distance from human disturbance. Seal densities reflect changes in the ecosystem’s overall productivity in different areas (Stirling and Oritsland, 1995). In the zone of floating shorefast ice of the Beaufort Sea, ringed seals range from 1.5-2.4 seals per square nautical mile (Map 6 shows the floating shorefast-ice [Frost, Lowry, and Burns, 1988a]). Surveys in May 1996 through 1999 recorded densities of about 0.81 seals per square kilometer in the Beaufort Sea fast-ice habitat (Frost and Lowry, 1999). The overall density from 1997 surveys was 0.90 seal/square kilometer, with a 95% confidence interval that the density ranged from 0.77-1.05 seals per square kilometer (Frost, Pendleton, and Hessinger, 2001). Ringed seals probably are a polygamous species. When sexually mature, they establish territories during the fall and maintain them during the pupping season. Pups are born in late March and April in lairs that seals excavate in snowdrifts and pressure ridges. During the breeding and pupping season, adults on shorefast ice (floating fast-ice zone) usually move less than individuals in other habitats; they depend on a relatively small number of holes and cracks in the ice for breathing and foraging. During nursing (4-6 weeks), pups usually stay in the birth lair. Alternate snow lairs provide physical and thermal protection when the pups are being pursued by polar bears and arctic foxes (Smith, Hammill, and Taugbol, 1991). The primary prey of ringed seals is arctic cod, saffron cod, shrimps, amphipods, and euphausiids (Kelly 1988; Reeves, Stewart, and Leatherwood, 1992). This species is a major resource that subsistence hunters harvest in Alaska (see Section III.C.2 Subsistence-Harvest Patterns).

Figure III.B-3a shows recorded ringed seal sightings in the Beaufort Sea Planning Area from 1987-1999 during the Bowhead Whale Aerial Surveys conducted by MMS. Most of the sightings were recorded during the fall (September through October).

III.B.6.b. Bearded Seal

This species is found throughout the Arctic and usually prefers areas of less-stable or broken sea ice, where breakup occurs early (Cleator and Stirling, 1990). Most of the bearded seals in Alaskan OCS areas are found in the Bering and Chukchi seas. Estimates on the abundance of bearded seals in the Beaufort Sea and in Alaskan waters currently are unavailable; however, the minimum population in Alaskan waters is expected to be at least 50,000 animals (Ferrero et al., 2000). Bearded seals stay on moving-ice habitat in the Beaufort Sea. Their densities in the western Beaufort Sea are greatest during the summer and lowest during the winter. Their most important habitat in winter and spring is active ice or offshore leads.

Pupping takes place on top of the ice less than 1 meter from open water (Kovacs, Lyderson, and Gjertz, 1996) from late March through May mainly in the Bering and Chukchi seas, although some takes place in the Beaufort Sea. These seals do not form herds but sometimes do form loose groups. Bearded seals feed on a variety of primarily benthic prey, decapod crustaceans (crabs and shrimp) and mollusks (clams), and other food organisms, including arctic and saffron cod, flounders, sculpins, and octopuses (Kelly 1988; Reeves, Stewart, and Leatherwood, 1992). Bearded seals (ugruk) are a main subsistence resource and a favorite food of subsistence hunters (residents of Barrow, as cited in S.R. Braund and Assocs. and University of Alaska, Anchorage [UAA], Institute for Social and Economic Research [ISER], 1993).

Figure III.B-3b shows bearded seal sightings in the Beaufort Sea Planning Area from 1979-1999 during the Bowhead Whale Aerial Surveys conducted by MMS and the Naval Ocean Systems Center. Most of the sightings were recorded during the fall (September through October). Their distribution is widely disbursed across the planning area. More bearded seals were observed in the eastern half of the Beaufort Sea than to the west.

III.B.6.c. Spotted Seal

The suggested minimum and maximum population estimate of spotted seals occurring along the western Alaskan coast is about 7,000 and 55,000 animals, respectively (Rugh, Shelden, and Withrow, 1997). Ferrero et al. (2000) estimated the population at about 59,000 animals. This species is a seasonal visitor to the Beaufort Sea from populations in the Bering/Chukchi seas, as indicated from satellite-tagged animals (Lowry et al., 2000). Spotted seals appear along the coast in July-August in low numbers (about 1,000 total for the Alaskan Beaufort Sea coast) hauling out on beaches, barrier islands, and remote sandbars on the river deltas. Beaufort Sea coastal haulout and concentration areas include the Colville River Delta, Peard Bay, and Oarlock Island in Dease Inlet/Admiralty Bay (Figure III.B-3c). Recently, these seals also have frequented Smith Bay at the mouth of the Piasuk River. Spotted seals frequently enter estuaries and sometimes ascend rivers, presumably to feed on anadromous fishes. In the Arctic, their diet is similar to that of ringed seals including a variety of fishes including arctic and saffron cod, and also shrimp, and euphausiids (Kato, 1982; Quakenbush, 1988; Reeves, Stewart, and Leatherwood,1992). Spotted seals migrate out of the Beaufort Sea in the fall (September to mid-October) as the shorefast ice re-forms and the pack ice advances southward. They spend the winter and spring periods offshore north of the 200-meter isobath along the ice front throughout the Bering Sea, where pupping, breeding, and molting occur (Lowry et al., 2000).

III.B.6.d. Walrus

The North Pacific walrus population was estimated at about 201,000 animals in 1990 (Seagars, 1992; Gilbert et al., 1992; USDOI, Fish and Wildlife Service, 1995), comprising about 80% of the world population. In general, most of this population is associated with the moving pack ice year-round. Walruses spend the winter in the Bering Sea; and the majority of the population summers throughout the Chukchi Sea, including the westernmost part of the Beaufort Sea. Although a few walruses may move east throughout the Alaskan portion of the Beaufort Sea to Canadian waters during the open-water season, the majority of the Pacific population is found west of 155° W. longitude north and west of Barrow, with the highest seasonal abundance along the pack-ice front (Figure III.B-3d).

Nearly all the adult females with dependent young migrate into the Chukchi Sea during the summer, while a substantial number of adult males remain in the Bering Sea. Spring migration usually begins in April, and most of the walruses move north through the Bering Strait by late June. Females with calves comprise most of the early spring migrants. During the summer, two large Arctic areas are occupied: from the Bering Strait west to Wrangell Island and along the northwest coast of Alaska from about Point Hope to north of Point Barrow. With the southern advance of the pack ice in the Chukchi Sea during the fall (October-December), most of the walrus population migrates south of the Bering Strait. Solitary animals occasionally may overwinter in the Chukchi Sea and in the eastern Beaufort Sea.

Walrus calves are born from mid-April to mid-June during the northward migration; mating takes place from January to March. The gross reproductive rate of walruses is considerably lower than that of seals. Prime reproductive females produce one calf every 2 years rather than one every year, as do other pinnipeds. Although bivalve mollusks-clams are the primary food of walruses, seals also are eaten by some walruses (Sease and Chapman, 1988; Lowry and Fay, 1984; Herman Rexford, as cited in UAA, ISER, 1982). In Barrow, walruses are a very important cultural and subsistence resource comprising the third most important species by weight of harvestable meat (Residents of Barrow, as cited in S.R. Braund and Assocs. and UAA, ISER, 1993).

Figure III. B-3d shows recorded walrus sightings in the Beaufort Sea Planning Area from 1979-1999 during the Bowhead Whale Aerial Surveys conducted by MMS and the Naval Ocean Systems Center. Most of the observations of walruses were in the far western part of the planning area. Few walruses were seen to the east.

III.B.6.e. Polar Bear

The Southern Beaufort Sea's population (from Icy Cape to Cape Bathurst, Northwest Territories, Canada) is about 1,800 bears (Gorbics, Garlich-Miller, and Schliebe, 1998). The current stock assessment is 2,272 and a minimum estimate of 1,971 bears (*Federal Register* March 28, 2002). This population has increased over the past 20-30 years at 2% or more per year and is believed to be increasing slightly or stabilizing near its carrying capacity (Amstrup, 1995; USDOI, Fish and Wildlife Service, 1995). Their seasonal distribution and local abundance vary widely in the Alaskan Beaufort Sea. Amstrup, Durner, and McDonald (2000) assumed a bear density of one bear per 25 square kilometers occurs in seasonal concentration areas. Much lower densities occur beyond 100 miles offshore and higher densities near ice leads, where seals concentrate during the winter. Another study estimated their overall density from Point Barrow to Cape Bathurst as one bear every 141-269 square kilometers (54-103 square miles) (Amstrup, Stirling, and Lentfer, 1986). Sea ice and food are the two most important natural influences on their distributions. Polar bears in the Alaskan arctic prey primarily on ringed seals and, to a lesser extent, bearded seals; walruses, and beluga whales are taken opportunistically (Amstrup and DeMaster, 1988).

Drifting pack ice off the coast of the Alaskan Beaufort Sea probably supports more polar bears than either shorefast ice or polar pack ice, probably because young seals are abundant in this habitat. Polar bears prefer rough sea ice, floe-edge ice, and moving ice over smooth ice for hunting and resting (Martin and Jonkel, 1983; Stirling, Andriashek, and Calvert, 1993). Polar bears sometimes concentrate along Alaska's coast when pack ice drifts close to the shoreline, at whale-carcass locations, and when shorefast ice forms early in the fall. Polar bears can swim great distances and are very curious animals (Adams, 1986, pers. commun.).

Pregnant and lactating females with newborn cubs are the only polar bears that occupy winter dens for extended periods. Typically, dens are more sparsely distributed in the Alaskan coastal zone than in areas receiving consistent use, areas such as Wrangell Island, Russia, and in Hudson Bay and James Bay, Canada. Pregnant females come to coastal areas in late October or early November to build maternity dens. Most onshore dens are close to the seacoast, usually not more than 8-10 kilometers inland (Figure III.B-3e). Offspring are born from early December to late January, and females and cubs break out from dens in late March or early April.

Polar bear dens have been located on river banks in northeast Alaska and on shorefast ice close to islands east of the mouth of the Colville River. Dens have been found recently in the proposed Liberty area. A greater number of dens have been recorded on the Arctic National Wildlife Refuge where topographic relief (hills, banks, and other terrain features) provides conditions where enough snow accumulates for bears to build dens. Polar bear hunters from Nuiqsut and Kaktovik identified several of the coastal den areas (USDOI, Fish and Wildlife Service, 1995; Kalxdorff, 1997). Female polar bears usually do not use the same den sites each year (Ramsay and Stirling, 1990; Amstrup, Garner, and Durner, 1992), but they often do use the same geographic areas (Amstrup, Garner, and Durner, 1992). Shifts in the distribution of den locations in Canada may be related to changes in sea-ice conditions (Ramsay and Stirling, 1990).

In addition to being protected by the Marine Mammal Protection Act of 1972, polar bears and their habitats are covered by the International Agreement on the Conservation of Polar Bears. This 1976 agreement among Canada, Denmark, Norway, the Union of Soviet Socialist Republics, and the United States addresses protecting "habitat components such as denning and feeding sites and migration patterns." Additionally, a bilateral agreement between the United States and Russia to conserve polar bears in the Chukchi/Bering seas was signed in October 2000.

The North Slope Borough/Inuvialuit Game Council's management of polar bears for the southern Beaufort Sea includes sustainable harvest quotas based on estimated population size, sustainable harvest rates for female polar bears, and information regarding the sex ratio of the subsistence harvest.

Figure III. B-3e shows recorded polar bear sightings in the Beaufort Sea Planning Area from 1979-1999 during the Bowhead Whale Aerial Surveys conducted by MMS and the Naval Ocean Systems Center. Polar bear sightings were widely distributed across the Beaufort Sea Planning Area. Concentrations were observed along the coast of the planning area.

III.B.6.f. Beluga Whale

The beluga whale, a subarctic and arctic species, is a summer seasonal visitor throughout offshore habitats of the Alaskan portion of the Beaufort Sea. The Beaufort population was currently estimated to be in excess of 32,000 whales (Ferrero et al., 2000). Most of this population migrates from the Bering Sea into the Beaufort Sea in April or May. However, some whales may pass Point Barrow as early as late March and as late as July (Frost, 1985, pers. commun.). The spring-migration routes through ice leads are similar to those of the bowhead whale. A major portion of the Beaufort Sea population concentrates in the Mackenzie River estuary during July and August. An estimated 2,500-3,000 belugas summer in the northwestern Beaufort and Chukchi seas, with some using coastal areas such as Peard Bay and Kasegaluk Lagoon (Frost, Lowry, and Burns, 1988b; Frost, Lowry, and Carroll, 1993). This eastern Chukchi Sea stock was estimated at a minimum of about 3,700 whales (Ferrero et al., 2000). Satellite tracking of 23 belugas from this stock indicate that these whales inhabit the eastern Beaufort Sea during the summer season (Suydam et al., 2001). In the Arctic, belugas feed primarily on arctic and saffron cod, whitefish, char, and benthic invertebrates (Hazard, 1988).

Fall migration through the western Beaufort Sea and the Sale 170 area is in September or October. Although small numbers of whales have been observed migrating along the coast (Johnson, 1979), surveys of fall distribution strongly indicate that most belugas migrate offshore along the pack-ice front (Frost, Lowry and Burns, 1988b; Treacy, 1988-1998, 2000). Beluga whales are an important subsistence resource of Inuit Natives in Canada and also to Inupiat Natives in Alaska (see Section III.C.2 Subsistence-Harvest Patterns).

Figure III. B-3f shows recorded beluga whale sightings in the Beaufort Sea Planning Area from 1979-1999 during the Bowhead Whale Aerial Surveys conducted by MMS and the Naval Ocean Systems Center. The majority of the beluga sightings were recorded offshore along the shelf break or further offshore during spring and fall migrations. Much smaller numbers of whales were seen in coastal waters in the planning area.

III.B.6.g. Gray Whale

Since receiving protection by the International Whaling Commission in 1946, the eastern Pacific gray whale population has increased from a few thousand individuals that survived commercial harvest to more than 21,000 (Breiwick et al., 1989; Withrow, 1989; National Marine Fisheries Service, 1991; Buckland et al., 1993). Evidence that the population had approached and exceeded pre-exploitation levels (Rice, Wolman, and Braham, 1984) prompted the National Marine Fisheries Service to issue a determination that the eastern North Pacific stock be removed from the List of Endangered and Threatened Wildlife (59 *FR* 31094-31095). The current minimum gray whale estimate is 26,635 with an estimated annual increase rate from 1967/1968-1995/1996 at 2.4% (Ferrero et al., 2000).

Most gray whales calve and breed from late December to early February in protected waters along the western coast of Baja California. Recent observations suggest that some calving occurs as far north as Washington prior to arrival on the calving grounds (Dohl et al., 1983; Jones and Swartz, 1987).

Northward migration, primarily of individuals without calves, begins in February; some cow/calf pairs delay their departure from the calving area until well into April (Jones and Swartz, 1984). Most whales occur within 15 kilometers of land but have been observed up to 200 kilometers offshore (Bonnell and Dailey, 1990). Much of the migration route north of Point Conception to and from summer feeding grounds in the northern Bering and southern Chukchi seas lies within a few kilometers of the coast or adjacent islands. Gray whales occur in the Gulf of Alaska in late March, April, May, and June and again in November and December (Rice and Wolman, 1971; Consiglieri et al., 1982).

A portion of the gray whale population summers along the west coast of North America south of the Bering Sea/Unimak Pass (56 *FR* 58870). Gray whales migrate into the northern Bering and Chukchi seas starting in late April through the summer open-water months and feed there until October-November (Miller, Johnson, and Doroshenko, 1985; Moore and DeMaster, 1997). They migrate out of the Chukchi and Beaufort seas with freezeup and migrate out of the Bering Sea during November-December (Rugh and Braham, 1979).

The majority of the eastern Pacific gray whale population feeds primarily on benthic amphipods in the northern feeding grounds of the Bering and Chukchi seas (Moore and DeMaster, 1997). Shallow coastal areas and offshore shoals in the Chukchi and western Beaufort seas provide rich benthic feeding habitat for gray whales during these months (Rugh et al., 1999). Gray whale feeding areas offshore of northern Alaska are characterized with low species diversity, high biomass, and the highest secondary production rates reported for any extensive benthic community (Rugh et al., 2000). Gray whales suck infauna amphipods from the fine sand on the ocean bottom, producing an extensive record of feeding craters 2-20 square meters in size (Kim and Oliver, 1988; Moore and DeMaster, 1997).
Figure III.B-3g shows recorded gray whale sightings in the Beaufort Sea Planning Area from 1979-1999 during the Bowhead Whale Aerial Surveys conducted by MMS and the Naval Ocean Systems Center. Most of the observations were west of Point Barrow, and few gray whales were seen east of Barrow.

III.B.7. Terrestrial Mammals

Among the terrestrial mammals that occur in the Beaufort Sea area, the caribou, muskox, grizzly bear, and arctic fox are the species most likely to be affected by development. Other species, such as moose, are too sparse in the project area to be affected by Beaufort Sea development.

III.B.7.a. Caribou

Among the terrestrial mammals that occur along the coast of the Beaufort Sea, barren-ground caribou is the species that could be affected most by proposed OCS oil and gas activities in the Beaufort Sea multiple-sale area. Two large and two smaller caribou herds use coastal habitats adjacent to the Beaufort Sea area: the Western Arctic, the Porcupine, the Central Arctic, and the Teshekpuk Lake herds.

III.B.7.a(1) Population Status and Range

The Western Arctic Herd was estimated at 430,000 animals (Bente, 2000). The herd ranges over territory in northwestern Alaska from the Chukchi coast east to the Colville River, and from the Beaufort coast south to the Kobuk River. In winter, the range extends south as far as the Seward Peninsula and Nulato Hills, and east as far as the Sagavanirktok River north of the Brooks Range and the Koyukuk River south of the Brooks Range. The Teshekpuk Lake Herd was estimated to number more than 28,000 animals in 1999 (Bente, 2000). The Teshekpuk Lake Herd has increased at a rate of 14% per year during between 1989 and 1993 and since then has stabilized or increased slightly (Bente, 2000). The Teshekpuk Lake Herd is found primarily within the National Petroleum Reserve-Alaska, with its summer range extending between Barrow and the Colville River. In some years, most of the Teshekpuk Lake Herd remains in the Teshekpuk Lake area all winter. In other years, some or all of the herd winters in the Brooks Range or within the range of the Western Arctic Herd.

The Central Arctic Herd was estimated at 27,000 (Lawhead and Prichard, 2001). Its range extends from the Itkillik River east to the Canning River, and from the Beaufort coast south into of the Brooks Range.

The Porcupine Caribou Herd was estimated to be about 178,000-180,000 animals in 1989 and then declined to 160,000 animals in 1992 and to 152,000 animals in 1994 (Whitten, 1992; Whitten, 1995, pers. commun.). The herd probably declined in response to lower yearling recruitment after harsh winters, and the herd continued to decline to an estimate of 129,000 animals in 1998 (Stephenson, 1999). The Porcupine Caribou Herd ranges south from the Beaufort Sea coast, from the Canning River of Alaska in the west, eastward through the northern Yukon and portions of the Northwest Territories in Canada, and south to the Brooks Range.

III.B.7.a(2) Migration

Caribou migrate seasonally between their calving areas, summer range, and winter range to take advantage of seasonally available forage resources. If movements are greatly restricted, caribou are likely to overgraze their habitat, leading to perhaps a drastic, long-term population decline. The caribou diet shifts from season to season and depends on the availability of forage. In general, the winter diet of caribou has been characterized as consisting predominantly of lichens and mosses, with a shift to vascular plants during the spring (Thompson and McCourt, 1981). However, when Teshekpuk Lake Herd caribou winter near Teshekpuk Lake, where relatively few lichens are present, this herd may consume more sedges and vascular plants.

Spring migration of parturient female caribou from the overwintering areas to the calving grounds starts in late March (Hemming, 1971). Often the most direct routes are used; however, certain drainages and routes probably are used during calving migrations, because they tend to be corridors free of snow or with shallow snow (Lent, 1980). Bulls and nonparturient females generally migrate at a very leisurely pace, with some remaining on winter ranges until June. Severe weather and deep snow can delay spring migration, with some calving occurring en route. Cows calving en route usually proceed to their traditional calving grounds (Hemming, 1971).

The spring migration to traditional calving grounds consistently provides high nutritional forage to lactating females during calving and nursing periods, which is critical for the growth and survival of newborn calves. *Eriophorum*-tussock-sedge buds (tussock cotton grass) appear to be very important in the diet of lactating caribou cows during the calving season (Lent, 1966; Thompson and McCourt, 1981; Eastland, Bowyer, and Fancy, 1989), while orthophyll shrubs (especially willows) are the predominant forage during the postcalving period (Thompson and McCourt, 1981). The availability of sedges during spring, which apparently depends on temperature and snow cover, probably affects specific calving locations and calving success.

The evolutionary significance of the establishment of the calving grounds, however, may relate directly to the avoidance of predation on the caribou calves, particularly predation by wolves (Bergerud, 1974, 1987). Caribou calves are very vulnerable to wolf predation, as indicated by the documented account of surplus predation by wolves on newborn calves (Miller, Gunn, and Broughton, 1985). By migrating north of the tree line, caribou leave the range of the wolf packs, which generally remain on the caribou winter range or in the mountain foothills or along the tree line during the wolf-pupping season (Heard and Williams, 1991; Bergerud, 1987). By calving on the open tundra, the cow caribou also avoid ambush by predators. The selection of snow-free patches of tundra on the calving grounds also helps to camouflage the newborn calf from other predators such as golden eagles (Bergerud, 1987). However, the sequential spring migration, first by cows and later by bulls and the rest of the herd, is believed to be a strategy for optimizing the quality of forage as it becomes available with snowmelt on the arctic tundra (Whitten and Cameron, 1980). The earlier migration of parturient cow caribou to the calving grounds also could reduce forage competition with the rest of the herd during the calving season.

III.B.7.a(3) Calving Grounds

Calving takes place in the spring, generally from late May to late June (Hemming, 1971). Calving areas for the Western Arctic, Teshekpuk Lake, and Central Arctic caribou herds are shown in Figure III.B-4. The Western Arctic Herd calving area is inland on the National Petroleum Reserve-Alaska, west of the planning area. The Teshekpuk Lake Herd’s central calving area generally is located on the east side of Teshekpuk Lake and near Cape Halkett, adjacent to Harrison Bay. The Central Arctic Herd generally calves within 30 kilometers of the Beaufort coast between the Itkillik and Canning rivers. The herd separates into two segments based on the locations of the calving concentration areas, one on each side of the Sagavanirktok River.

The Porcupine Caribou Herd’s calving range encompasses an area along the Beaufort Sea coast from the Canning River in Alaska to the Babbage River in Canada and south to the northern foothills of the Brooks Range (Figure III.B-4). Major concentrations of calving cows of the Porcupine Caribou Herd occur within this range between the Canning and Sadlerochit rivers on the west and east, respectively, and between Camden Bay on the north and the Sadlerochit Mountains on the south.

During the postcalving period in July through August, caribou generally attain their highest degree of aggregation with continuous masses of animals in herds, such as the Porcupine Caribou Herd, in excess of tens of thousands. Cow/calf groups are most sensitive to human disturbance during this period. During the summer months, caribou use various coastal habitats of the Beaufort Sea in Alaska, such as sandbars, spits, river deltas, and some barrier islands, for relief from insect pests.

III.B.7.a(4) Summer Distribution and Insect-Relief Areas

During calving and postcalving periods, cow/calf groups are most sensitive to human disturbance. They join into increasingly larger groups, foraging primarily on the emerging buds and leaves of willow shrubs and dwarf birch (Thompson and McCourt, 1981). In the postcalving period (July through August), caribou attain their highest degree of aggregation. Members of the Western Arctic Herd may be found in continuous herds numbering in excess of tens of thousands of individuals, and portions of the Western Arctic Herd may be found throughout their summer range.

Insect-relief areas become important during late June to mid-August during the insect season (Lawhead, 1997). Insect harassment reduces foraging efficiency and increases physiological stress (Reimers, 1980). For insect relief, caribou use various coastal and upland habitats such as sandbars, spits, river deltas, some barrier islands, mountain foothills, snow patches, and sand dunes, where stiff breezes prevent insects from concentrating and alighting on the caribou. In the planning area, members of the Teshekpuk Lake Herd generally aggregate close to the coast for insect relief. Some small groups, however, gather in other cool, windy areas such as the Pik Dunes located about 30 kilometers south of Teshekpuk Lake (Hemming, 1971; Philo, Carroll, and Yokel, 1993). Caribou aggregations move frequently from insect-relief areas along the arctic coast (the Central Arctic, Western Arctic, and especially the Teshekpuk Lake herds) and in the mountain foothills (some aggregations of the Western Arctic Herd) to and from green foraging areas.

III.B.7.a(5) Winter-Range Use and Distribution

Western Arctic Herd caribou generally reach their winter ranges in early to late November and remain on the range through March (Hemming, 1971; Henshaw, 1968). The primary winter range of the Western Arctic Herd is located south of the Brooks Range along the northern fringe of the boreal forest. During winters of heavy snowfall or severe ice crusting, caribou may overwinter within the mountains or on the Arctic Slope (Hemming, 1971). Even during normal winters, some caribou of the Western Arctic Herd overwinter on the Arctic Coastal Plain. The Teshekpuk Lake Herd was believed to reside year-round in the Teshekpuk Lake area (Davis, Valkenburg, and Boertje, 1982); however, satellite-collar data from Teshekpuk Lake caribou indicate that some animals travel great distances to the south, as far as the Seward Peninsula (Carroll, 1992). The Central Arctic Herd overwinters primarily in the northern foothills of the Brooks Range (Roby, 1980).

The movement and distribution of caribou over the winter ranges reflect their need to avoid predators and their response to wind (storm) and snow conditions (depth and snow density), which greatly influence the availability of winter forage (Henshaw, 1968; Bergerud, 1974; Bergerud and Elliot, 1986). The numbers of caribou using a particular portion of the winter range are highly variable from year to year (Davis, Valkenburg, and Boertje, 1982; Fancy et al., 1990, as cited in Whitten, 1990). Range condition, distribution of preferred winter forage (particularly lichens), and predation pressure all affect winter distribution and movements (Roby, 1980; Miller, 1974; Bergerud, 1974).

III.B.7.b. Muskoxen

Indigenous populations of muskoxen were extirpated in the 1800's in northern Alaska (Smith, 1989). Muskoxen were reintroduced east of the National Petroleum Reserve-Alaska on the Arctic National Wildlife Refuge in 1969 and in the Kavik River area (between Prudhoe Bay and the Refuge) in 1970; they were reintroduced west of the National Petroleum Reserve-Alaska near Cape Thompson in 1970 and 1977 (Smith, 1989). The reintroductions to the east established the Arctic National Wildlife Refuge population, which grew rapidly and expanded both east and west of the Refuge (Garner and Reynolds, 1986). An estimated 270 muskoxen were counted between the Colville River and the Refuge, 91 animals were recorded west of the Trans-Alaska Pipeline near the Colville River (Whitten, 1997, pers. commun.), and a breeding population has become established in the Itkillik-Colville rivers area (Johnson et al., 1996). The latter is the closest known breeding population to the planning area. The number of muskoxen that occur within the planning area is unknown. A total of about 800 muskoxen were observed in the 500-kilometer area between the Itkillik River west of Prudhoe Bay and the Babbage River in northwestern Canada (Reynolds, 1998). Probably a transitory number of lone bulls frequent the planning area, coming from populations that breed east of the Colville River. Muskoxen are expected to repopulate their former home-range habitats in the National Petroleum Reserve-Alaska in the near future (McCabe, 1977, pers. commun.). The most important habitats for muskoxen in the Colville River Delta are riparian, upland shrub and moist sedge-shrub meadows (Johnson et al., 1996).

Muskoxen generally do not migrate but will move in response to seasonal changes in snow cover and vegetation. They use riparian habitats along the major river drainages on the Arctic Slope year-round. Calving takes place from about April to early June (Garner and Reynolds, 1987). Distribution of muskoxen during the calving season, summer, and winter are similar, with little movement during winter (Reynolds, 1992). Only 14 muskoxen were sighted in the project area (LGL, Woodward-Clyde, and Applied Sociocultural Research, 1998) mostly along the Kadleroshilik River.

III.B.7.c. Grizzly Bears

The grizzly bear population on the western North Slope was considered stable or slowly increasing in 1991. Densities were highest in the foothills of the Brooks Range and lowest on the Arctic North Slope (Carroll, 1991). On the North Slope, grizzly bear densities vary from about 0.3-5.9 bears per 100 square miles, with a mean density of 1 bear per 100 square miles. The number of grizzly bears using the Prudhoe Bay and Kuparuk oil fields adjacent to the central Beaufort Sea area has increased in recent years. An estimated 60-70 bears or approximately 4 per 1,000 square kilometers currently inhabit the oil-field area (Shideler and Hechtel, 2000). The State of Alaska, Department of Fish and Game captured and marked 27 bears while studying the bears' use of the oil fields (Shideler and Hechtel, 1995). These bears have very large home ranges (2,600-5,200 square kilometers) and travel up to 50 kilometers a day (Shideler and Hechtel, 1995). Since 1991, 17 grizzly bears were recorded in the Beaufort Sea area (LGL, Woodward-Clyde, and Applied Sociocultural Research, 1998). On the North Slope, grizzly dens occur in pingos, banks of rivers and lakes, sand dunes, and steep gullies in uplands (Harding, 1976; Shideler and Hechtel, 1995). Bears enter dens primarily in the last 2 weeks of October and emerge from the dens in early May (McLoughlin, Cluff, and Messier, 2002). The grass meadows on the bluffs along the Colville River are used by foraging bears during the spring (Swem, 1997, pers. commun.).

Densities were highest in the foothills of the Brooks Range and lowest in the northern portion of the National Petroleum Reserve-Alaska (Carroll, 1991). On the North Slope, grizzly bear densities vary from about 0.3-5.9 bears per 100 square miles, with a mean density of 1 bear per 100 square miles. In 1989, the population of the western North Slope (Game Management Unit 26A) was estimated at between 500 and 720 bears (Trent, 1986; Carroll, 1991). The number of grizzly bears using the Prudhoe Bay and Kuparuk oil fields east of the Petroleum Reserve has increased in recent years: 27 bears were captured and marked by the Alaska Department of Fish and Game in studies of bear use of the oil fields (Shideler and Hechtel, 1995). These bears have very large home ranges (2,600-5,200 square kilometers) and travel up to 50 kilometers a day (Shideler and Hechtel, 1995).

III.B.7.d. Arctic Foxes

The arctic fox population on the North Slope has increased since 1929, as the values and harvest rates of white fox pelts declined (Chesemore, 1967). Fox populations peak whenever lemmings (their main prey) are abundant. Other food sources include ringed seal pups and the carcasses of other marine mammals and caribou, which are important throughout the year (Chesemore, 1967; Hammill and Smith, 1991). Tundra-nesting birds also are a large part of their diet during the summer (Chesemore, 1967; Fay and Follmann, 1982; Quinlan and Lehnhausen, 1982; Raveling, 1989). The availability of winter food sources directly affects the foxes' abundance and productivity (Angerbjorn et al., 1991). Arctic foxes on the Prudhoe Bay oil field readily use development sites for feeding, resting, and denning; their densities are greater in the oil fields than in surrounding undeveloped areas (Eberhardt et al., 1982; Burgess et al., 1993). Development on the Prudhoe Bay oil fields probably has led to increases in fox abundance and productivity (Burgess, 2000). However, arctic foxes are particularly subject to outbreaks of rabies, and their populations tend to fluctuate with the occurrence of the disease and with changes in the availability of food. Marine mammals are an important part of the diet of arctic foxes that occur along the coast of western Alaska (Anthony, Barten, and Seiser, 2000).

III.B.8. Vegetation and Wetlands

Detailed information on vegetation of the central Arctic Coastal Plain, including the Prudhoe Bay oil fields and the Beaufort Sea planning area, is available in Walker and Acevedo (1987) (U. S. Geological Survey Beechey Point Quadrangle, vegetation and land cover series L-0211). The authors produced comprehensive vegetation maps and reports that not only describe the area's vegetation but also provide techniques to show the changes over time resulting from oil-field development.

Sedge, grasses, and shrubs dominate the vegetation classes. Water sedge (*Carex aquatilis*) is the dominant species in the wet tundra class, in both of the flooded tundra classes, and in the one aquatic class that bears its name. Pendant grass, *Arctophila fulva*, dominates the other aquatic class. *Eriophorum vaginatum*, commonly called tussock cotton grass, dominates the tussock tundra class. Common shrub species include mountain alder (*Alnus crispa*), dwarf birch (*Betula nana*), four-angled mountain heather (*Cassiope tetragona*), crowberry (*Empetrum nigrum*), *Ledum palustre*, cloudberry (*Rubus chamaemorus*), bog blueberry (*Vaccinium uliginosum*), lingonberry (*Vaccinium vitis-idaea*), and species of the genera *Andromeda*, *Arctostaphylos*, *Dryas*, and willow (*Salix*). *Salix* and *Alnus* (to a much lesser extent) are the dominant species of the low and tall shrub classes. Except for *Betula*, all are dwarf shrubs.

The four dominant types of plant cover area typical of the North Slope (Beechey Point Quadrangle, Walker and Acevedo, 1987) are:

- Open-water and pond complexes having more than about 40% open water with aquatic grass tundra (about 70% of the land cover).
- Wet herbaceous tundra dominated by wet-sedge (*Carex*) and cotton-grass species (*Eriophorum*). It has little permanent water or up to 40% water-covered ground or 30% moist herbaceous tundra that includes wet coastal areas periodically flooded with saltwater (about 13% of the total land cover).
- Moist or dry tundra dominated by dwarf shrubs such as willow (*Salix*), lichens, and forbs.
- Barren areas along major streams composed of 60% barren peat, mineral soil, or gravel. These areas may have patches with sparse cover of forbs and dwarf shrubs.

The Beaufort planning area's coast includes eroding bluffs, sandy beaches alternating with lower tundra areas having some saltwater intrusions, sand dunes, sandy spits, and estuarine areas at the mouths of streams. Deltas of the Colville, Sagavanirktok, Kadleroshilik, and Shaviovik rivers support a complex mix of wet arctic saltmarsh, dry coastal barrens, salt-killed tundra, typical moist and wet tundra, and dry, partially vegetated gravel bars. In freshwater wetlands, high abundances of invertebrate populations correlate strongly with the presence of emerging water sedge (*Carex*) and pendant grass (*Arctophila*) (Bergman et al., 1977).

The Arctic Coastal Plain on the National petroleum Reserve-Alaska is dominated by many lakes and is very poorly drained. About 20% of the Petroleum Reserve coastal plain is open water, while another 18% has standing water with varying proportions of plant cover. The single most common cover type is the cotton grass tussock. Tussock-tundra represents about 45% of the plant cover (USDOI, Bureau of Land Management and MMS 1998).

Water sedge *(Carex aquatilis)* is the dominant species in the wet tundra vegetation class. Pendant grass (*Arctophila fulva)* is dominant in the aquatic class. Other common grass/sedge species occurring in the moist tundra classes are tussock-cotton-grass species (*Eriophorum angustifolium, Eriophorum russeolum*, and *Eriophorum vaginatum*), *Arctagrostis latifolia, Deschampsia ceaspitosa, Cochlearia officianalis, Poa lanata,* and *Puccinellia phryganodes*. *Eriophorum vaginatum*, commonly referred to as tussock cotton grass, is the dominant species of the tussock tundra class.

Some of the commonly occurring herbaceous species are *Caltha palustris, Epilobium latifolium, Petasites frigidus, Potentilla palustre*, and species of the genera *Draba, Papaver, Pedicularis, Polygonum, Ranunculus, Rumex, Saxifraga, Senecio*, and *Stellaria*.

Common shrub species include alder (*Alnus crispa*), dwarf birch (*Betula nana*), mountain heath (*Cassiope tetragona)*, crowberry (*Empetrum nigrum*), cloudberry (*Rubus chamaemorus*), bog blueberry (*Vaccinium uliginosum*), lingonberry (*Vaccinium vitis-idaea*), and species of the genera *Andromeda, Arctostaphylos, Dryas*, and willow (*Salix)*. *Salix* and, to a much lesser extent, *Alnus*, are the dominant species of the low and tall shrub classes. With the exception of Betula, the remainder are dwarf shrubs.

There are seven species of rare vascular plants known to occur on the North Slope (Lipkin, 1997). *Mertensia drummondii* has been found on sand dune habitats along the Kogosukruk River and west of the planning area along the Meade River. *Potentilla stipularis* has been found at Umiat. This species occurs in sandy substrates, such as sandy meadows, and riverbank silts and sands other than dunes. *Pleuropogon sabinei* is an aquatic grass that rarely occurs between the *Arctophila* and *Carex* vegetation zones in lakes and ponds. This species is known from a few locations north and northeast of Teshekpuk Lake. Because relatively little plant-survey work has been done on Alaska's North Slope, these species might be found at additional sites. *Draba adamsii* has been found near Barrow in eroding, turfy polygons by the ocean or streams. This species may be precluded from areas farther south by its adaptation to low temperatures. *Poa hartzii* is a grass known from sites on the Meade River and within the Arctic National Wildlife Refuge. It is found on the dry sands of some active floodplains. *Erigeron muirii* might be found on some drier soils, such as ridges in the foothills region. *Aster pygmaeus* is known from sites east of the Petroleum Reserve on mudflats and saline soil.

III.C. Social Systems

The following six resource categories describe the social systems environment:
- Economy
- Subsistence-Harvest Patterns
- Sociocultural Systems
- Archaeological Resources
- Land Use Plans and Coastal Management Program

Environmental Justice

III.C.1. Economy

III.C.1.a. Revenues

III.C.1.a(1) North Slope Borough Revenues

The North Slope Borough received no OCS revenues for the period 1995-2000.

The tax base in the North Slope Borough since the 1980's has consisted mainly of high-value property owned or leased by the oil industry in the Prudhoe Bay area. In Fiscal Year 1995, more than 95% of revenues came from property taxes, according to the final EIS for Sale 144 (USDOI, MMS, 1996a:Section III.C.1).

North Slope Borough revenues (exclusive of The North Slope Borough School District) were $224-$235 million between 1992 and 1997. Revenues were $285, $266, and $245 million in 1998, 1999, and 2000, respectively (Abbott, 2001, pers. commun.). In 1997, the assessed value of all property was $11.7 billion; in 1998, 1999, and 2000, assessed values were $11.4, $10.8, and $10.8 billion, respectively. The North Slope Borough projects total assessed value will decline steadily from $10 billion in 2002 to $5 billion in 2013 (Wright, 2001, pers. commun.).

In Fiscal Year 1994, the North Slope Borough applied a rate of 18.5 mills to assessed property: 4.78 mills for operations and 13.72 mills for debt service. Although the mill rate for operations is at the limit allowed by State statutes, the North Slope Borough's mill rate to repay bonded indebtedness is unlimited. Therefore, the North Slope Borough can raise the mill rate to repay bonds without legal restraints, and limits on short-term revenues do not drive current capital expenditures. The State perceives a limit of 20 mills on the rate for oil and gas property; thus, self-limitation at an 18.5-mill rate leaves the North Slope Borough a buffer to increase revenues, if assessed values fall unexpectedly (Nageak, 1998).

Between 1966 and 1995 the State of Alaska allocated $66,000 for two projects under the Land and Water Conservation program. Under the Federal coastal impact assistance program, the State allocated $1.9 million on a one-time basis to the North Slope Borough (www.gov.state.ak.us/dgc/CIAP September 2001).

III.C.1.a(2) State Revenues

The Federal Government distributed OCS revenues from Beaufort Sea Lease Sales to the State of Alaska for rents, bonuses, royalties, escrow funds, and settlement payments as follows:

- 1995, $9.4 million
- 1996, $9.5 million
- 1997, $17.3 million
- 1998, $13.6 million
- 1999, $14.7 million
- 2000, $13.7 million

The OCS revenues the Federal Government distributed to the State are greater than those collected in the 1995-2000 period enumerated in the next subsection, because the revenues distributed to the State include funds held in escrow from previous years and distributed after 1994. From 1986-2000, the Federal Government distributed $505 million in OCS revenues to the State of Alaska. State income tax and state spill and conservation tax related to the Beaufort Sea OCS from 1995-1998 is zero.

The Federal Government has allocated $20 million of OCS revenues through the Federal Land and Water Conservation Fund to the State of Alaska between 1966 and 1995. The State, in turn, allocated these funds to local jurisdictions for eligible projects.

Congress amended the OCS Lands Act to enable the coastal impact assistance program. This program makes a one-time allocation of $12 million to the State of Alaska. Of this, the State retains $8 million and allocates the balance to coastal political subdivisions according to a formula specified by the amended act (www.gov.state.ak.us/dgc/CIAP September 2001).

The State of Alaska revenues budgeted for expenditure varied between $3.7 billion in 1998 and $4.3 billion in 2001 (www.legfin.state.ak.us/BudgetReports/Operating/).

III.C.1.a(3) Federal Revenues

Total Federal OCS revenues for the Beaufort Sea, which include bonuses, royalties, and rents, are:

- 1995, $1.1 million
- 1996, $16.1 million
- 1997, $1.1 million
- 1998, $7.4 million
- 1999, $1.4 million
- 2000, $1.4 million

Of these revenues, bonuses in the 1995-2000 period were $14.4 million for Sale 144 in 1996 and $5.3 million for Sale 170 in 1998. Total revenues from the Alaska OCS from 1976-2000 were $6.4 billion.

Federal income tax collected from OCS workers is estimated to be $1.1 million for drilling and related activity on Warthog and Liberty islands in 1997. There was no income tax in 1995, 1996, or 1998-2000, because there was no worker activity on the OCS.

Total Federal receipts of all types, including personal income tax, corporation tax, and other types of revenue varied from $1.7 trillion in 1998 to $2.0 trillion in 2001 (www.whitehouse.gov/omb/budget/index.html).

III.C.1.b. Employment and Personal Income

III.C.1.b(1) History of Employment in the North Slope Borough

Approximately 70% of the oil and gas industry workers on the North Slope commute to permanent residences in Alaska but outside the North Slope Borough, primarily in Southcentral Alaska and Fairbanks. Approximately 30% reside outside Alaska (Hadland and Landry, 2002; Hadland, 2002, pers. commun.).

The number of those who work and reside on the North Slope Borough is so small as to be statistically negligible (see Section III.C.1.b(4)).

Table III.C-1 shows North Slope Borough employment data, as a whole and by sector, including the oil-industry workers at Prudhoe Bay between 1990 and 1998. While the table lists "mining," the data for this industry is completely oil and gas employment at Prudhoe Bay and nearby facilities. The total North Slope Borough employment, less mining, reflects workers who reside permanently in the borough. The Borough reports:

> Since its incorporation, the North Slope Borough has expended millions of dollars for construction projects on work-force development programs to improve the living conditions, employment rates, and skills of its residents. [Since 1972,] the number of Inupiat who have skills and experience on construction projects, from training programs and most recently from educational opportunities available through Ilisagvik College, has slowly risen (North Slope Borough, 1999).

For a summary description of the North Slope Borough employment, see Table III.C-2, 1998 Employment by Employer, North Slope Borough, Nuiqsut, Kaktovik, and Barrow; Table III.C-3, 1998 Employment by Employer: Employees by Ethnicity, North Slope Borough; and Table III.C-4, 1998 Labor Force Summary North Slope Borough, Nuiqsut, Kaktovik, and Barrow. For further details on employment, see the Final EIS for Sale 170 (USDOI, MMS, 1998:Section III.C.1), which is incorporated here by reference.

III.C.1.b(2) The North Slope Borough is the Largest Employer of Permanent Residents in the Borough

The North Slope Borough's government employs many people directly and finances construction projects under its Capital Improvement Program. For details, see the description in the previous paragraphs and in the final EIS for Sale 170 (USDOI, MMS, 1998:Section III.C.1).

III.C.1.b(3) Unemployment in the North Slope Borough

According to State figures, unemployment in the North Slope Borough was 3.5-9.4% from 1975-2001 (www.labor.state.ak.us/research). However, according to the 1993 North Slope Borough Census, 22% of the North Slope Borough's resident labor force believed themselves to be underemployed, and 24% worked less than 40 weeks in 1993 (North Slope Borough, 1995). According to the State Department of Labor, the North Slope Borough had 16% unemployment in 1998. According to the 1998 North Slope Borough Census, 13% of the North Slope Borough's resident labor force perceived themselves to be under employed, and 27% worked less than 40 weeks in 1998 (North Slope Borough, 1999). For these data for the North Slope Borough, Nuiqsut, Kaktovik, and Barrow see Table III.C-5, 1998 Unemployment and Underemployment. For further discussion and details, see North Slope Borough (1995: NSB-28 through NSB-42, 1999: NSB-41 through NSB-54) and USDOI, MMS (1998:Section III.C.1).

III.C.1.b(4) North Slope Oil-Industry Employment of North Slope Borough Resident Natives

Very few North Slope Natives have been employed in the oil-production facilities and associated work in and near Prudhoe Bay since production started in the late 1970's. Also, North Slope Natives are not motivated to move because of employment. This historical information is relevant to assessing potential economic effects of proposed oil and gas exploration and development and development on the North Slope Native population. A study contracted by MMS shows that 34 North Slope Natives interviewed comprised half of all North Slope Natives who worked at Prudhoe Bay in 1992, and that the North Slope Natives employed at Prudhoe Bay comprised less than 1% of the 6,000 North Slope oil-industry workers (USDOI, MMS, 1993). This pattern is confirmed by 1998 data showing only 10 North Slope Borough Inupiat residents as employed in the oil industry (see Table III.C-3).

One of the North Slope Borough's main goals has been to create employment for Native residents. It has been successful in hiring many Native people for the North Slope Borough's construction projects and operations. Only a few permanent residents hold jobs at the industrial enclaves at Prudhoe Bay.

The North Slope Borough has tried to facilitate employment of Native people in the oil industry at Prudhoe Bay. They are concerned that the oil industry has not done enough to train unskilled laborers or to allow them to participate in subsistence hunting. The North Slope Borough also is concerned that the oil industry recruits using methods common to western industry. The North Slope Borough would like to see serious efforts by industry to hire the North Slope Borough's residents (Nageak, 1998). For further information, see USDOI, MMS (1998:Section III.C.1).

The purpose of BPXA's Itqanaiyagvik Program is to increase North Slope Borough Native employment. It is a joint venture with the Arctic Slope Regional Corporation and its oil-field subsidiaries and is being coordinated with the North Slope Borough and the North Slope Borough's School District (BPXA, 1998b). Nanook Incorporated, a subsidiary of Kuukpik Corporation, based in Nuiqsut, has a training program that could be used to train Natives for positions in the oil industry, such as technicians and other long-term jobs. Nanook Incorporated could work with other village corporations on the North Slope (Helms, as cited in USDOI, MMS, Alaska OCS Region, 2002c)

Some Natives residing in the North Slope Borough have worked in the North Slope oil industry. The account of one Native provides an example of a Native who has found work in the oil industry in the past. Mr. Long found work as early as 1969, at first as a roustabout, then later as a floor hand on a drill rig, and then as a chain thrower. Mr. Long indicates that in recent years, operations are so automated the industry needs fewer workers and, thus, workers have more difficulty finding jobs, especially Natives Long, as cited in USDOI, MMS, Alaska OCS Region, 2002c)

III.C.1.b(5) Most North Slope Oil-Industry Workers Reside in Southcentral Alaska and Fairbanks

In the past, most workers at oil operations centered at Prudhoe Bay commuted between worker enclaves on the North Slope and permanent residences in other parts of the State and outside the State. See Section III.C.1.b(1) for more information on this point.

Employment in the Anchorage-MatSu Region, the Kenai Peninsula Borough, and Fairbanks North Star Borough is shown in Table III-C-6.

III.C.1.b(6) U.S. Employment

The total employment in the U.S. was 137 million workers in 1999 (www.bea.doc.gov/bea/regional/). This employment figure is comparable to the employment figures in Tables III.C-1 and III.C-6 for the North Slope Borough, and Southcentral Alaska and Fairbanks.

III.C.1.b(7) Personal Income

Aggregate personal income in 1999 was:

- North Slope Borough, $0.2 billion.
- South Central Alaska (Municipality of Anchorage, Matanuska-Susitna Borough, and Kenai Peninsula Borough) and Fairbanks Northstar Borough, $13.2 billion.
- U.S., $7,739.4 billion (www.bea.doc.gov/bea/regional/)

Per capita personal income, rounded to the nearest thousand dollars, in 1999 was:

- North Slope Borough, $29,000.
- Municipality of Anchorage, $34,000
- Matanuska-Susitna Borough, $19,000
- Kenai Peninsula Borough, $25,000
- Fairbanks Northstar Borough, $26,000
- U.S., $28,000 (www.bea.doc.gov/bea/regional/)

III.C.1.c. Subsistence as a Part of the North Slope Borough's Economy

The predominately Inupiat residents of the North Slope Borough traditionally have relied on subsistence activities. Although not fully part of the cash economy, subsistence hunting is important to the North Slope Borough's whole economy and even more important to the culture (see Sections III.C.2 and III.C.3). Households do need to expend cash to purchase equipment used in the subsistence harvest, such as boats, rifles, all-terrain vehicles, snowmobiles, etc. Inupiat are the prevailing ethnic group making expenditures for subsistence-harvest equipment. See Table III.C-7 for 1998 Annual Household Subsistence Expenditures by Ethnicity.

III.C.2. Subsistence-Harvest Patterns

Characteristics of Harvest Patterns: This section describes the subsistence-harvest patterns of the Inupiat (Eskimo) communities adjacent to the Beaufort Sea multiple-sale area: Barrow, Nuiqsut, and Kaktovik. This community-by-community description provides general information on subsistence-harvest patterns, harvest information by resource and community, timing of the subsistence-harvest cycles, and harvest-area concentrations by resource and by community. Further information regarding the harvest areas, species harvested, and quantities harvested can be found in the final EIS's for Beaufort Sea Sales 144 and 170 (USDOI, MMS, 1996a, 1998). The following summary description is augmented by information from current studies, including State of Alaska, Department of Fish and Game (1995), S.R. Braund and Assocs. (1996), Kruse et al. (1983), Alaska Natives Commission (1994), City of Nuiqsut (1995), and USDOI, MMS (1996b, 1996c), in addition to the National Petroleum Reserve-Alaska Final Integrated Activity Plan EIS (USDOI, Bureau of Land Management and MMS, 1998) and the Liberty Development and Production Plan final EIS (USDOI, MMS, Alaska OCS Region, 2002a). A study titled *Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow: Past and Present Comparison* is ongoing and will map geographic patterns of subsistence use near important North Slope communities. The MMS will use this comparative time-series information to assess cumulative sociocultural effects in the Beaufort Sea region.

III.C.2.a. Definition of Subsistence

Generally, subsistence is considered hunting, fishing, and gathering for the primary purpose of acquiring traditional food. The Alaska National Interest Land Conservation Act defines subsistence as the customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of nonedible byproducts of fish and wildlife resources taken for personal or family consumption; for barter or sharing for personal or family consumption; and for customary trade (16 U.S.C. § 3113). The North Slope Borough Municipal Code defines subsistence as an activity performed in support of the basic beliefs and nutritional needs of the residents of the borough and includes hunting, whaling, fishing, trapping, camping, food gathering, and other traditional and cultural activities (North Slope Borough Municipal Code 19.20.020 (67)). As a lifeway for Native Alaskans, subsistence is more than the harvesting, processing, sharing, and trading of marine and land mammals, fish, and plants. Subsistence should be understood to embody cultural, social, and spiritual values that are the essence of Alaskan Native cultures (Bryner, 1995; State of Alaska, Dept. of Natural Resources, 1997).

The community residents adjacent to the Beaufort Sea multiple-sale area participate in a subsistence way of life. While new elements have been added to the way people live, this way of life is a continuation of centuries-old Inupiat traditional patterns. Until January 1990, Alaska statutes defined "subsistence uses" as "the non-commercial, customary and traditional uses of wild, renewable resources by a resident domiciled in a rural area of the state for personal or family consumption" (AS § l6.05.940); and subsistence uses were given priority over other uses. In January 1990, as a result of *McDowell vs. State of Alaska*, this law was declared unconstitutional by the Alaska Supreme Court. However, Federal law (Title VIII of the Alaska National Interest Land Conservation Act) continues to define Alaskan subsistence and grants it priority over other uses. The new ruling means Alaska cannot legally (according to State law) establish rural preference for subsistence. The effect of the Alaska Supreme Court's decision was stayed until July 1, 1990. The State had until then to devise a solution to the issues raised in the *McDowell* decision. The Alaska State Legislature has not been able to pass any subsistence legislation despite special sessions called for that purpose and other efforts initiated more recently by Governor Tony Knowles. On Federal lands and navigable waters in Alaska, Federal laws grant subsistence priority over other uses, and Federal Agencies are now managing these subsistence hunts and will continue to do so until State legislation can be enacted (USDOI, Fish and Wildlife Service, 1992). Spurred by a number of recent court decisions and the

State of Alaska's failure to enact a subsistence plan that guarantees some type of rural preference, the management of subsistence fisheries on Federal lands is now under the auspices of the Fish and Wildlife Service *(Anchorage Daily News*, 1996).

III.C.2.b. The Cultural Importance of Subsistence

Subsistence activities are assigned the highest cultural values by the Inupiat and provide a sense of identity in addition to being an important economic pursuit. Many species are important for the role they play in the annual cycle of subsistence-resource harvests, yet effects on subsistence can be serious, even if the net quantity of available food does not decline. Subsistence resources provide more than dietary benefits. They also provide materials for personal and family use, and the sharing of resources helps maintain traditional Inupiat family organization. Subsistence resources also provide special foods for religious and social occasions; the most important ceremony, Nalukataq, celebrates the bowhead whale harvest. The sharing, trading, and bartering of subsistence foods structures relationships among communities, while at the same time the giving of such foods helps maintain ties with family members elsewhere in Alaska.

III.C.2.c. Community Subsistence-Harvest Patterns

Two major subsistence-resource categories occur on the North Slope: the coastal/marine and the terrestrial/aquatic. In the coastal/marine group, the food resources harvested are whales, seals, walruses, waterfowl, and fish. In the terrestrial/aquatic group, the resources sought are caribou, freshwater fishes, moose, Dall sheep, edible roots and berries, and furbearers. Generally, communities harvest resources most available to them, and harvests tend to be concentrated near communities, along rivers and coastlines, and at particularly productive sites. The distribution, migration, and the seasonal and more extended cyclical variation of animal populations make determining what, where, and when a subsistence resource will be harvested a complex choice. Many areas might be used infrequently, but they can be quite important harvest areas when they are used (USDOI, Bureau of Land Management, 1978c). Under certain conditions, harvest activities may occur anywhere in the sale area; but they tend to be concentrated along rivers and coastlines, near communities, and at particularly productive sites.

Use by a village of any particular species can vary greatly over time, and data from short-term harvest surveys often can lead to a misinterpretation of use/harvest trends. For example, if a particular village did not harvest any bowhead whales in one year, the volume of whale in their diet would decrease. Consequently, consumption and use of caribou and other species likely would go up, in absolute and percent terms. If caribou were not available one winter, other terrestrial species could be hunted with greater intensity. The harvest of faunal resources, such as marine and terrestrial mammals and fish, is heavily emphasized, and the subsistence harvest of vegetation by communities adjacent to the project area is limited. When compared with more southerly regions, the total spectrum of available resources in the arctic region is limited.

While subsistence-resource harvests differ from community to community, the resource combination of caribou, bowhead whales, and fish has been identified as the primary grouping of resources harvested. Caribou is the most important overall subsistence resource in terms of effort spent hunting, quantity of meat harvested, and quantity of meat consumed. The bowhead whale is the subsistence resource of primary importance, because it provides a unique and powerful cultural basis for sharing and community cooperation (Stoker, 1984, as cited by Alaska Consultants, Inc. [ACI], Courtnage, and Braund, 1984). In fact, the bowhead could be said to be the foundation of the sociocultural system. Depending on the community, fish is the next most important resource after caribou and bowhead whales. Bearded seals and various types of birds also are considered primary subsistence species. Waterfowl are particularly important during the spring, when they provide variety to the subsistence diet and the first fresh meat of the season. In the late 1970's, when bowhead whale quotas were low and the Western Arctic caribou herd crashed (and the Alaska Board of Game put bag limits in place), hunters turned to bearded seals (ugruk), ducks, geese, and fish to supplant the subsistence diet. Seal oil from bearded seals is an important staple and a necessary complement to other subsistence foods.

The subsistence pursuit of bowhead whales has major importance to the communities of Barrow, Nuiqsut, and Kaktovik and continues today to be the most valued activity in the subsistence economy of these communities. This is true even in light of harvest constraints imposed by quotas of the International Whaling Commission; relatively plentiful supplies of other resources such as caribou, fish, and other subsistence foods; and supplies of retail grocery foods. Whaling traditions include kinship-based crews, use of skin boats (only in Barrow for their spring whale-hunting season), distribution of the meat, and total community participation and sharing. In spite of the rising cash income, these traditions remain as central values and activities for all Inupiat on the North Slope. Bowhead whale hunting strengthens family and community ties and the sense of a common Inupiaq heritage, culture, and way of life. In this way, whale-hunting activities provide strength, purpose, and unity in the face of rapid change. In terms of the whale harvest, Barrow is the only community within the planning area that harvests whales in both the spring and the fall. Nuiqsut and Kaktovik residents hunt bowheads only during the fall whaling season.

An important shift in subsistence-harvest patterns occurred in the late 1960's, when the substitution of snowmachines for dogsleds decreased the importance of ringed seals and walruses as key sources of dog food and increased the relative importance of waterfowl. This shift illustrates how technological and/or social change can lead to modified subsistence practices. Because of technological and harvest-pattern changes, the dietary importance of waterfowl also may continue to increase; however, these changes would not affect the central and specialized dietary roles that bowhead whales, caribou, and fish—the three most important subsistence-food resources to North Slope communities—play in the subsistence harvests of Alaska's Inupiat, and for which there are no practical substitutes.

Subsistence resources used by Barrow, Nuiqsut, and Kaktovik are listed in Table III.C-8 by common species name, Inupiaq name, and scientific name. For a comparison of the proportion of Inupiaq household foods obtained from subsistence in the years 1977, 1988, and 1993, see Table III.C-9. Table III.C-10 shows the percentage of households that participated in successful harvests of subsistence resources in the three communities being discussed, and Table III.C-11 shows individual species' percentages of the total subsistence harvest for each community.

Many species are important for the role they play in the annual cycle of subsistence-resource harvests, yet effects on subsistence can be serious even if the net quantity of available food does not decline. The consumption of harvestable subsistence resources provides more than dietary benefits, it also provides materials for personal and family use, and the sharing of resources helps maintain traditional Inupiat family organization. Subsistence resources provide special foods for religious and social occasions; the most important ceremony, Nalukataq, celebrates the bowhead whale harvest. The sharing, trading, and bartering of harvestable subsistence foods structures relationships among communities while, at the same time, the giving of such foods helps maintain ties with family members elsewhere in Alaska. Additionally, subsistence provides a link to the cash economy; many households within the communities earn cash from crafting whale baleen and walrus ivory and from harvesting furbearing mammals.

Full-time wage employment has positively affected the subsistence hunt on the one hand by providing cash for snowmachines, boats, motors, and fuel—important tools for the hunt. Yet, on the other hand, full-time employment limits the time a subsistence hunter can spend hunting to after work hours. During midwinter, this time is further limited by waning daylight. In summer, extensive hunting and fishing activities can be pursued after work without any daylight limitations.

Inupiat concerns regarding oil development for the Beaufort Sea multiple sales that have been identified during scoping can be divided into six categories: (1) disruption of subsistence species' migrations; (2) direct damage to subsistence resources and habitats; (3) disruption of access to subsistence areas; (4) loss of subsistence food sources; (5) concerns over cumulative oil-development impacts; and (6) insufficient recognition of Inupiat indigenous knowledge concerning subsistence resources, subsistence-harvest areas, and subsistence practices. One study of Inupiat concerns about oil development was based on a compilation of approximately 10 years of recorded testimony at North Slope public hearings for State and Federal energy-development projects. Most concerns confirmed those raised in scoping, centering on the subsistence use of resources, including damage to subsistence species, loss of access to subsistence areas, loss of Native foods, or interruption of subsistence-species migration. These four concerns represent 83% of all the concerns heard in the testimony taken on the North Slope for this period (S.R. Braund and

Assocs., In prep.; Kruse et al., 1983:Table 35; USDOI, MMS, 1994; Human Relations Area Files, Inc., 1992).

III.C.2.d. Annual Cycle of Harvest Activities

This section provides general information regarding subsistence-harvest patterns in all of the communities close to the Beaufort Sea multiple-sale area. The primary subsistence-harvest areas for Barrow, Nuiqsut, and Kaktovik are depicted in Figure III.C-1 Subsistence-Harvest Areas for Beaufort Sea Communities. The entire marine subsistence-harvest areas of Nuiqsut and Kaktovik and most of Barrow's marine-subsistence-harvest area lie within or near the boundary of the Beaufort Sea multiple-sale area; portions of Barrow's marine-subsistence-harvest area in the Chukchi Sea lie to the west and outside the boundary of the Beaufort Sea multiple-sale area. Onshore, the caribou-hunting areas of Barrow, Nuiqsut, and Kaktovik would be most directly affected by potential pipelines and other onshore facilities associated with the proposed action. Figures III.C.3-2 through III.C.3-7a in the Beaufort Sea Sale 144 final EIS depict subsistence-harvest-concentration areas for bowhead whales, beluga whales, caribou, seals, walrus, fish, and waterfowl, respectively and are incorporated here by reference. The annual subsistence cycles for Barrow, Nuiqsut, and Kaktovik are described in the following.

III.C.2.d(1) Barrow

As with other communities adjacent to the planning area, Barrow residents (population 3,469 in 1990, 3,908 in 1993, 4,641 in 1998, and 4,581 in 2000 [USDOC, Bureau of the Census, 1991 and 2001; North Slope Borough, Dept. of Planning and Community Services, 1994, 1999) enjoy a diverse resource base that includes both marine and terrestrial animals. Barrow's location is unique among the communities in the sale area: the community is a few miles southwest of Point Barrow, the demarcation point between the Chukchi and Beaufort seas. This location offers superb opportunities for hunting a diversity of marine and terrestrial mammals and fishes. Barrow's subsistence-harvest area can be seen in Figure III.C-1. Subsistence resources used by Barrow are listed in Table III.C-8 by common species name, Inupiaq name, and scientific name. Specific subsistence-harvest areas for major subsistence resources for Barrow are shown in Figure III.C-2. Figure III.C-3 shows Barrow harvest sites recorded by Braund from 1987 through 1990 (S.R. Braund and Assocs. and UAA, ISER, 1993), and Figure III.C-4 depicts known Barrow hunting and fishing camps.

III.C.2.d.(1)(a) Bowhead Whale

Unlike residents of Nuiqsut and Kaktovik, Barrow residents hunt the bowhead whale during both spring and fall; however, more whales are harvested during the spring whale hunt, which is the major whaling season (Figure III.C-5). In 1977, the International Whaling Commission established an overall quota for subsistence hunting of the bowhead whale by the Alaskan Inupiat. The quota currently is regulated by the Alaska Eskimo Whaling Commission, which annually decides how many bowheads each whaling community may take. Barrow whalers continue to hunt in the fall to meet their quota and to seek strikes that can be transferred to the community from other villages from the previous spring hunt. During the spring hunt, there are approximately 30 whaling camps along the edge of the landfast ice. The locations of these camps depend on ice conditions and currents. Most whaling camps are located south of Barrow, some as far south as Walakpa Bay. Typically, Atqasuk whalers participate in the subsistence bowhead hunt by joining Barrow whaling crews.

Depending on the season, the bowhead is hunted in two different areas. In the spring (from early April until the first week of June), the bowheads are hunted from leads that open when pack-ice conditions deteriorate. At this time, bowhead whales are harvested along the coast from Point Barrow to the Skull Cliff area, and the distance of the leads from shore varies from year to year. The leads generally are parallel and quite close to shore, but occasionally they break directly from Point Barrow to Point Franklin and force Barrow whalers to travel over the ice as much as 10 miles offshore to the open leads. Typically, the lead is open from Point Barrow to the coast; and hunters whale only 1-3 miles from shore. A stricken whale can be chased in either direction in the lead. Spring whaling in Barrow is conducted almost entirely with skin boats because the narrow leads prohibit the use of aluminum skiffs, which are more difficult to maneuver than the traditional skin boats (ACI, Courtnage, and Braund, 1984; S.R. Braund and Assocs. and UAA, ISER, 1993). Fall whaling occurs east of Point Barrow from the Barrow vicinity to Cape Simpson. Hunters use aluminum skiffs with outboard motors to chase the whales during the fall migration, which takes place in open water up to 30 miles offshore.

No other marine mammal is harvested with the intensity and concentration of effort that is expended on the bowhead whale. Bowheads are very important in the subsistence economy; from 1962-1982, they accounted for 21.3% (an average of 10.10 whales/year) of the annual subsistence harvest (ACI, Courtnage, and Braund, 1984). From 1987 through 1990, Braund (S.R. Braund and Assocs. and UAA, ISER, 1993) conducted a 3-year subsistence study in Barrow. Table III.C-12 shows the number of various subsistence species harvested by year and the 3-year average reported in the study. During the last year of the study, harvest data indicated that 58.2% of the total harvest was marine mammals, and 43.3% of the total harvest was bowhead whales (State of Alaska, Dept. of Fish and Game, 1995b; Table III.C-12). As with all species, the harvest of bowheads varies from year to year; over the past 30 years (see Figures III.C-5 and III.C-6), the number taken each year has varied from zero to 23. In the memory of community residents, 1982 is the only year in which a bowhead whale was not harvested (ACI, Courtnage, and Braund, 1984; S.R. Braund and Assocs. and UAA, ISER, 1993).

III.C.2.d(1)(b) Beluga Whale

Beluga whales are available from the beginning of the spring whaling season through June and occasionally in July and August in ice-free waters (Figure III.C-5). Barrow hunters do not like to hunt beluga whales during the bowhead hunt, preferring to harvest them after the spring bowhead season ends, which depends on when the bowhead quota is met. Belugas are harvested in the leads between Point Barrow and Skull Cliff. Later in summer, belugas occasionally are harvested on both sides of the barrier islands of Elson Lagoon. The annual average beluga harvest over the 20-year period from 1962-1982 is estimated at 5 whales, or 5% of the total annual subsistence harvest (ACI, Courtnage, and Braund, 1984). In Braund's (1993) study, there were no harvests of beluga whales in the 3-year period of data collection (S.R. Braund and Assocs. and UAA, ISER, 1993; State of Alaska, Dept. of Fish and Game, 1995b; Table III.C-12). During the period 1982-1996, belugas were taken very rarely at Barrow, with an annual average of about one per year. In 1997, five belugas had been taken as of August (Suydam, 1997, pers. commun.).

III.C.2.d(1)(c) Caribou

Caribou, the primary terrestrial source of meat for Barrow residents, are available throughout the year, with peak-harvest periods from February through early April and from late June through late October (Figure III.C-5). The approximate boundary for Barrow's primary subsistence-harvest area for caribou, as reflected in research conducted in the late 1980's and early 1990's, extends southwest from Barrow along the Chukchi coast for roughly 35 miles, then runs south and eastward toward the drainage of the upper Meade River; it swings easterly crossing the Usuktuk River and then trends north and east crossing the Topagoruk and Oumalik rivers until it reaches Teshekpuk Lake; from here the boundary generally traces the coastline back to Barrow. (The area described here is a boundary that circumscribes reported harvest sites and does not represent a reported harvest area as such [S.R. Braund and Assocs. and UAA, ISER, 1993].) Over the 20-year period from 1962-1982, residents harvested an annual average of 3,500 caribou, which accounted for 58.2% of the total annual subsistence harvest (ACI, Courtnage, and Braund, 1984). In the last year of Braund's 3-year Barrow subsistence study, caribou provided 22.2% of the total edible pounds harvested (S.R. Braund and Assocs. and UAA, ISER, 1993; State of Alaska, Dept. of Fish and Game, 1995b; Table III.C-12).

II.C.2.d(1)(d) Seals

Hair seals are available from October through June; however, because of the availability of bowheads, bearded seals, and caribou during various times of the year, seals are harvested primarily during the winter months, especially from February through March (Figure III.C-5). Ringed seals are the most common hair seal species harvested, and spotted seals are harvested only in the ice-free summer months. Ringed seal hunting is concentrated in the Chukchi Sea, although some hunting occurs off Point Barrow and along the barrier islands that form Elson Lagoon. During the winter, leads in the area immediately adjacent to Barrow and north toward the point make this area an advantageous spot for sealing. Spotted seals also are harvested occasionally off Point Barrow and the barrier islands of Elson Lagoon. Oarlock Island in Admiralty Bay is a favorite place for hunting spotted seals. From 1962-1982, the hair seal harvest ranged between 31 and 2,100 seals a year, with the average annual harvest estimated at 955 seals, or 4.3% of the total annual subsistence harvest (ACI, Courtnage, and Braund, 1984). In the last year of Braund's 3-year Barrow subsistence study, ringed seals provided 2.1% of the total edible pounds harvested (S.R. Braund and Assocs. and UAA, ISER, 1993; State of Alaska, Dept. of Fish and Game, 1995b; Table III.C-12).

The hunting of bearded seals (ugruk) is an important subsistence activity in Barrow, because the bearded seal is a preferred food and because bearded seal skins are the preferred covering material for the skin boats used in whaling. Six to nine skins are needed to cover a boat. For these reasons, bearded seals are harvested more than the smaller hair seals. Most bearded seals are harvested during the spring and summer months and from open water during the pursuit of other marine mammals in both the Chukchi and Beaufort seas (North Slope Borough, 1998). Occasionally, they are available in Dease Inlet and Admiralty Bay. No early harvest data were available for the number of bearded seals harvested annually; thus, the annual subsistence harvest averaged over 20 years from 1962-1982 was only 150 seals, or about 2.9% of the total annual subsistence harvest (ACI, Courtnage, and Braund, 1984). Harvests from 1988-1989 were documented at 213 seals, providing 6.0% of the total edible pounds harvested (S.R. Braund and Assocs. and UAA, ISER, 1993; Table III.C-13).

III.C.2.d(1)(e) Fishes

Barrow residents harvest marine and riverine fishes, but their dependency on fish varies according to the availability of other resources. Capelin, char, cod, grayling, salmon, sculpin, trout, and whitefish are harvested (ACI, Courtnage, and Braund, 1984). Fishing occurs primarily in the summer and fall months and peaks in September and October (Figure III.C-5). Fishing also occurs concurrently with caribou hunting in the fall. Tom cod are harvested during the fall and early winter when there is still daylight (North Slope Borough, 1998). The subsistence-harvest area for fish is extensive, primarily because Barrow residents supplement their camp food with fish whenever they are hunting.

Most fishing occurs at inland fish camps, particularly in lakes and rivers that flow into the southern end of Dease Inlet (Craig, 1987). Inland fish camps are found in the Inaru, Meade, Topagoruk, Chipp, Alaktak, and Ikpikpuk river drainages and as far as Teshekpuk Lake. Inland fisheries within or adjacent to the planning area are those on the Alaktak and Ikpikpuk drainages and on Teshekpuk Lake. At established fish camps, hunters place set nets for whitefish, char, and salmon. These camps provide good fishing opportunities as well as access to inland caribou and birds. When whitefish and grayling begin to migrate out of the lakes into the major rivers in August, inland fishing intensifies. This also is the period of peak collection of berries and greens (Schneider, Pedersen, and Libbey, 1980; ACI, Courtnage, and Braund, 1984). During 1969-1973, the average annual harvest of fish was about 80,000 pounds (Craig, 1987); from 1962-1982, the estimated annual average was 60,000 pounds, which account for 6.6% of the total annual subsistence harvest (ACI, Courtnage, and Braund, 1984). In a 1986 partial estimate of fish harvests for the Barrow fall fishery in the Inaru River, the catch composition was least cisco (45%), broad whitefish (36%), humpback whitefish (16%), Arctic cisco (1%), fourhorn sculpin (1%), and burbot (0.5%) (Craig, 1987). In Braund's (1993) study, 1989-1990 fish harvests provided 13.5% of the total edible subsistence harvest (S.R. Braund and Assocs. and UAA, ISER, 1993; Table III.C-12).

III.C.2.d(1)(f) Walrus

Walruses are harvested during the summer marine-mammal hunt west of Point Barrow and southwest to Peard Bay. Most hunters will travel no more than 15-20 miles to hunt walruses. The major walrus-hunting effort occurs from late June through mid-September, with the peak season in August (Figure III.C-5). The annual average harvest over 20 years from 1962-1982 was estimated at 55 walruses, or 4.6% of the total annual subsistence harvest (ACI, Courtnage, and Braund, 1984). Braund's 1987-1990 study (S.R. Braund and Assocs. and UAA, ISER, 1993; Table III.C-12) indicated an increased walrus harvest, with a harvest of 88 walruses providing 10.9% of the total edible pounds of meat harvested during this period. From 1989-1995, 109 walruses were harvested, from a low of 1 in 1989 to a high of 30 in 1993 (Stephensen, Cramer, and Burn, 1994; Cramer, 1996, pers. commun.).

III.C.2.d(1)(g) Waterfowl

Migratory birds, particularly eider ducks and geese, provide an important food source for Barrow residents. This is not because of the quantity of meat harvested or the time spent hunting them, but because of the dietary importance of birds as the first source of fresh meat in the spring. In May, geese are hunted and hunters travel great distances along major inland rivers and lakes to harvest them; most eider and other ducks are harvested along the coast (Schneider, Pedersen, and Libbey, 1980). Once harvested extensively, snowy owls are no longer taken regularly. Eggs from a variety of species still are gathered occasionally, especially on the offshore islands where foxes and other predators are less common. Waterfowl, hunted during the whaling season (beginning in late April or early May) when their flights follow the open leads, provide a source of fresh meat for whaling camps. Later in the spring, Barrow residents harvest many geese and ducks, with the harvest peaking in May and early June but continuing until the end of June (Figure III.C-5). Birds may be harvested throughout the summer, but only incidentally to other subsistence activities. In late August and early September, with peak movement in the first 2 weeks of September, ducks and geese migrate south and are again hunted by Barrow residents. Birds, primarily eiders and other ducks, are hunted along the coast from Point Franklin to Admiralty Bay and Dease Inlet. Concentrated hunting areas also are located along the shores of the major barrier islands of Elson Lagoon. During spring whaling, families not involved with whaling may go geese hunting; successful whaling crews also may be hunting geese while other crews are still whaling (North Slope Borough, 1998).

A favorite spot for hunting birds is the “shooting station” at the narrowest point of the barrier spit that forms Point Barrow and separates the Chukchi Sea from Elson Lagoon. This area, a highly successful hunting spot during spring and fall bird migrations, is easily accessible to Barrow residents. Barrow residents harvested an estimated annual average from 1962-1982 of 8,000 pounds of birds, which accounted for about 0.9% of the total annual subsistence harvest (ACI, Courtnage, and Braund, 1984). From 1989-1990, 29,215 pounds were harvested, accounting for 3.3% of the total edible pounds harvested (S.R. Braund and Assocs. and UAA, ISER, 1993; State of Alaska, Dept. of Fish and Game, 1995b; Table III.C-12).

III.C.2.d(1)(h) Polar Bear

Barrow residents hunt polar bears from October to June (Figure III.C-5). Polar bears comprise a small portion of the Barrow subsistence harvest, with an annual average of 7.8 bears harvested from 1962-1983, or only 0.3% of the annual subsistence harvest (Schliebe, 1983; ACI, Courtnage, and Braund, 1984). From 1989-1990, 39 polar bears were harvested, providing 2.2% of the total edible pounds harvested (S.R. Braund and Assocs. and UAA, ISER, 1993; State of Alaska, Dept. of Fish and Game, 1995b; Table III.C-13). Table III.C-14 shows polar bear harvests from 1983-1995 for Barrow, Nuiqsut, and Kaktovik.

Figures III.C-7 and III.C-8 are derived from a North Slope Borough subsistence study conducted in 1993 and indicate the level of household consumption of subsistence foods and expenditures on subsistence activities (Harcharek, 1995).

III.C.2.d(2) Nuiqsut

Specific harvest areas for wildfowl, caribou, moose, fish, whales, and seals for Nuiqsut are shown on Map 9. The Inupiat community of Nuiqsut has subsistence-harvest areas in and adjacent to the sale area, and Nuiqsut’s entire marine subsistence-harvest area lies within proposed boundary of the Beaufort Sea multiple-sale area. Cross Island and vicinity is a crucially important region for Nuiqsut’s subsistence bowhead whale hunting. Before oil development at Prudhoe Bay, the onshore area from the Colville River Delta in the west to Flaxman Island in the east and inland to the foothills of the Brooks Range (especially up the drainages of the Colville, Itkillik, and Kuparuk rivers) was historically important to Nuiqsut for the subsistence harvests of caribou, waterfowl, furbearers, fish, and polar bears. Offshore, in addition to bowhead whale hunting, seals historically were hunted as far east as Flaxman Island. Also, commercial whaling near and within the barrier islands during the late 1800’s has been documented (Thomas P. Brower, as cited in North Slope Borough, Commission on History and Culture, 1980). Bowheads also have been observed inshore of the barrier islands, and recent mention has been made of the area being used as a whale feeding area (V. Nauwigewauk, as cited in Shapiro, Metzner, and Toovak, 1979; Isaac Akootchook, as cited in USDOI, MMS, 1979a; Thomas P. Brower, as cited in North Slope Borough, Commission on

History and Culture, 1980; Frank Long, Jr., as cited in Dames and Moore, 1996b; Burton Rexford, as cited in USDOI, MMS, 1996d; and Isaac Nukapigak, as cited in USDOI, MMS, Alaska OCS Region, 1998b).

Nuiqsut Subsistence-Harvest Seasons and Harvest Success Profile: Nuiqsut's population stood at 354 in 1990, 418 in 1993, 420 in 1998, and 433 in 2000 [USDOC, Bureau of the Census, 1991, 2001; North Slope Borough, Dept. of Planning and Community Services, 1994, 1999). Nuiqsut is located near the mouth of the Colville River, which drains into the Beaufort Sea. For Nuiqsut, important subsistence resources include bowhead whales, caribou, fish, waterfowl, ptarmigan and, to a lesser extent, seals, muskoxen, and Dall sheep. Polar bears, beluga whales, and walruses are seldom hunted but can be taken opportunistically while in pursuit of other subsistence species. A 1993 Department of Fish and Game subsistence study showed that nearly two-thirds of all Nuiqsut households received more than half of their meat, fish, and birds from local subsistence activity (Pedersen et al., 1995, as cited in Fall and Utermohle, 1995). Nuiqsut's marine and terrestrial subsistence-harvest areas can be seen in Figure III.C-1 and Map 9. The preferred harvest periods for Nuiqsut are indicated in Figure III.C-9. A summary of subsistence resources harvested in the 1993 and 1994-1995 seasons can be seen in Tables III.C-15 and III.C-16, respectively. A map of Nuiqsut's terrestrial harvest areas can be seen in Figure III.C-10.

III.C.2.d(2)(a) Bowhead Whale

Even though Nuiqsut is not located on the coast but approximately 25 miles inland with river access to the Beaufort Sea, bowhead whales are a major subsistence resource. Bowhead whale hunting usually occurs between late August and early October, with the exact timing depending on ice and weather conditions. Ice conditions can dramatically extend the season up to 2 months or contract it to less than 2 weeks. Unlike the Barrow spring whale hunt, staged from the edge of ice leads using skin boats, Nuiqsut whalers use aluminum skiffs with outboard motors to hunt bowheads in open water in the fall. Generally, bowhead whales are harvested by Nuiqsut residents within 10 miles of Cross Island, but hunters may at times travel 20 miles or more from the island. Historically, the entire coastal area from Nuiqsut east to Flaxman Island and the Canning River Delta has been used, but whale hunting to the west of Cross Island has never been as productive and whale hunting too far to the east requires long tows of the whales back to Cross Island for butchering, creating the potential for meat spoilage (Impact Assessment, Inc., 1990a).

In the past, Nuiqsut has not harvested many bowhead whales (20 whales from 1972-1995); however, their success has improved over the past few years. Unsuccessful harvests were more common in the 1980s, with no whales taken in 1983, 1984, 1985, and 1988; however, in the 1990s, the only unsuccessful years have been 1990 and 1994 (USDOI, MMS, 1996a; U.S. Army Corps of Engineers, 1998) (see Figures III.C-6 and III.C-14). A 1993 Alaska Department of Fish and Game subsistence survey in Nuiqsut indicated that 31.8% of the total subsistence harvest was marine mammals, and 28.7% of the total harvest was bowhead whales (State of Alaska, Dept. of Fish and Game, 1995a; Tables III.C-15 and III.C-16). The harvest of bowhead whales at Nuiqsut greatly affects the percentage of total harvest estimates because in years when whales are taken, other important subsistence species are underrepresented due to the great mass of the total pounds of whale harvested.

Although in Nuiqsut bowheads are not the main subsistence resource in terms of edible pounds harvested per capita, they remain, as in other North Slope communities, the most culturally prominent to the Inupiat. The bowhead is shared extensively with other North Slope communities and often with Inupiat residents in communities as far away as Fairbanks and Anchorage. Nuiqsut Whaling Captains Association President, Frank Long, Jr., presented a history of Nuiqsut bowhead whaling and summarized major issues of concern in the Proceedings of the 1995 Arctic Synthesis Meeting (USDOI, MMS 1996d).

III.C.2.d(2)(b) Caribou

Nuiqsut harvests several large land mammals, including caribou and moose; of these, caribou is the most important subsistence resource. Caribou may be the most preferred mammal in Nuiqsut's diet and, during periods of high availability, it provides a source of fresh meat throughout the year. Caribou-harvest statistics for 1976 show that 400 caribou provided approximately 47,000 pounds of meat, an estimated 90.2% of the total subsistence harvest (Stoker, 1983, as cited in ACI, Courtnage, and Braund, 1984; S.R. Braund and Assocs. and UAA, ISER, 1993; see Tables III.C-15 and III.C-16). In 1985, an estimated 513 caribou were harvested, providing an estimated 60,000 edible pounds of meat (37.5% of the total subsistence harvest; State of Alaska, Dept. of Fish and Game, 1993). A 1993 Alaska Department of Fish and Game subsistence study estimated a harvest of 674 caribou, providing about 82,000 edible pounds of meat (30.6% of the total subsistence harvest). In 1993, 74% of Nuiqsut households harvested caribou, 98% used caribou, 79% shared caribou with other households, and 79% received caribou shares (State of Alaska, Dept. of Fish and Game, 1995a). Harvests occurred at 16 locations with the highest harvest, 111 caribou, at Fish Creek (Pedersen et al., 1995, as cited in Fall and Utermohle, 1995). A subsistence-harvest survey conducted by the North Slope Borough, Division of Wildlife Management covering the period from July 1994 to June 1995 reported 249 caribou harvested by Nuiqsut hunters, or 58% of the subsistence harvest in edible pounds. The report noted this as quite a low number of caribou when compared to reported harvests for earlier years (see Table III.C-16). Explanations offered by local hunters were: (1) the need to travel longer distances to harvest caribou than in the past; (2) the increasing numbers of muskoxen (that hunters believe keep caribou away from traditional hunting areas); and (3) restricted access to traditional subsistence-hunting areas due to oil exploration and development in these areas (Brower and Opie, 1997; Brower and Hepa, 1998).

Because of the unpredictable movements of the Central Arctic and Teshekpuk Lake caribou herds, and because of ice conditions and hunting techniques that depend on the weather, Nuiqsut's annual caribou harvest can fluctuate markedly; but when herds are available and when weather permits, caribou are harvested year-round. Elders Samuel and Sarah Kunaknana related that caribou hunters in the past had to go inland to hunt caribou, because they never came down to the coast as they do now (Shapiro, Metzner, and Toovak, 1979).

III.C.2.d(2)(c) Fishes

Fish provides the most edible pounds per capita of any subsistence resource harvested by Nuiqsut (see Tables III.C-15 and III.C-16; State of Alaska, Dept. of Fish and Game, 1993, 1995a). The harvests of most subsistence resources, such as caribou, can fluctuate widely from year to year because of variable migration patterns and because harvesting techniques depend on ice and weather conditions, much the same as the conditions surrounding the bowhead whale hunt. Even though fish-harvest rates (and total catch) vary from year to year, the harvest of fish is perhaps more consistent than the harvest of land animals. The harvesting of fish is not subject to seasonal limitations, a situation that adds to their importance in the community's subsistence round. Nuiqsut has been shown to have the largest documented subsistence fish harvest on the Beaufort Sea coast (Moulton, 1997; Moulton, Field, and Brotherton, 1986). Moreover, in October and November, fish may provide the only source of fresh subsistence foods.

Fishing is an important activity for Nuiqsut residents because of the community's location on the Nechelik Channel of the Colville River, which has large resident fish populations on the North Slope. The river supports 20 species of fish, and approximately half of these are taken by Nuiqsut residents (George and Nageak, 1986). Local residents generally harvest fish during the summer and fall, but the fishing season basically runs from January through May and from late July through mid-December. The summer, open-water harvest lasts from breakup to freezeup (early June to mid-September). The summer harvest covers a greater area, is longer than the fall/winter harvest, and a greater number of species are caught. Broad whitefish is the primary anadromous species harvested during the summer. Thomas Napageak relates that

> …in the summer when it is time to fish for large, round-nosed whitefish the place called Tirragruag gets filled with them as well as the entrance to Itqiliq. Nigliq River gets filled with nets all the way to the point where it begins. We do not go to Kuukpiluk in the summer months. Then we enter Fish Creek...another place where they fish for whitefish is Nuiqsagruaq (Thomas Napageak [USDOI, BLM, 1998]).

In July, lake trout, northern pike, broad whitefish, and humpback whitefish also are harvested south of Nuiqsut. Traditionally, coastal areas were fished in June and July, when rotting ice created enough open water for seining. Nuiqsut elder Sarah Kunaknana, interviewed in 1979, said: "...in the little bays along the coast we start seining for fish (iqalukpik). After just seining 1 or 2 times, there would be so many fish we would have a hard time putting them all away" (Shapiro, Metzner, and Toovak, 1979). Salmon species reportedly have been caught in August but not in large numbers. Pink and chum are the most commonly caught salmon, although there reportedly has not been a great interest in harvesting them (George and Nageak, 1986). Arctic char is found in the main channel of the Colville River but does not appear to be a major subsistence species because, although apparently liked, it is not abundantly caught (George and Nageak, 1986; George and Kovalsky, 1986; State of Alaska, Dept. of Fish and Game, 1993, 1995a).

The fall/winter under-ice harvest of fish begins after freezeup, when the ice is safe for snowmachine travel. Local families begin fishing approximately 1 month after freezeup. The Kuukpigruaq Channel is the most important fall fishing area in the Colville region, and the primary species harvested are arctic and least cisco. Even after freezeup, people continue to fish for whitefish (Thomas Napageak [USDOI, BLM, 1998]). Nuiqsut resident Ruth Nukapigak recounts a recent winter fishing trip in December 1997: "I, myself, took my net out in December right before Christmas Day. I was catching whitefish in my net." (USDOI, BLM, 1998). Arctic and least cisco amounted to 88 and 99% of the harvest in 1984 and 1985, respectively; however, this percentage varied greatly depending on the net-mesh size. Humpback and broad whitefish, sculpin, and some large rainbow smelt also are harvested, but only in low numbers (George and Kovalsky, 1986; George and Nageak, 1986). A fish identified as "spotted least cisco" also has been harvested. This fish is not identified by Morrow (1980) but could be a resident form of least cisco (George and Kovalsky, 1986). Additionally, weekend fishing for burbot and grayling occurs at Itkillikpaat, 6 miles from Nuiqsut (George and Nageak, 1986; State of Alaska, Dept. of Fish and Game, 1995a).

A study conducted in 1985 estimated the summer catch that season totaled about 19,000 pounds of mostly broad whitefish; in the fall, approximately 50,000 pounds of fish were caught, for an annual per capita catch of 244 pounds; some of this catch was shipped to Barrow (Craig, 1987). A 1985 Alaska Department of Fish and Game subsistence survey estimated a smaller per capita catch with the edible pounds of all fish harvested at 176.13 pounds per capita (44.1% of the total subsistence harvest; State of Alaska, Department of Fish and Game, 1993). In 1986, there was a reduced fishing effort in Nuiqsut, and the fall harvest was only 59% of that taken in 1985 (Craig, 1987). In 1992, 34% of the edible pounds of the total subsistence harvest was fish and, by 1993, the estimate for edible pounds of all fish harvested had risen to 250.62 pounds per capita (33.7% of the total subsistence harvest [George and Fuller, 1997; State of Alaska, Dept. of Fish and Game, 1995a]). A subsistence-harvest survey conducted by the North Slope Borough, Division of Wildlife Management covering the period from July 1994 to June 1995 reported that the subsistence fishing provided 30% of the total subsistence harvest (see Table III.C-16; Brower and Opie, 1997; Brower and Hepa, 1998). A recent survey shows that 80% of all Nuiqsut households participate in some fishing activity (State of Alaska, Dept. of Fish and Game, 1995a).

Fish are eaten fresh or frozen. Because of their important role as an abundant and stable food source, and as a fresh-food source during the midwinter months, fish are shared at Thanksgiving and Christmas feasts and given to relatives, friends, and community elders. Fish also appear in traditional sharing and bartering networks that exist among North Slope communities. Because it often involves the entire family, fishing serves as a strong social function in the community, and most Nuiqsut families (out of a total 91 households in 1993) participate in some fishing activity (State of Alaska, Dept. of Fish and Game, 1995b).

III.C.2.d(2)(d) Seals

Seals are hunted year-round, but the bulk of the seal harvest takes place during the open-water season, with breakup usually occurring in June. In the spring, seals can be hunted once the landfast ice goes out. Present-day sealing is most commonly done at the mouth of the Colville when it begins flooding in June. According to Thomas Napageak:

> …when the river floods, it starts flowing out into the ocean in front of our village affecting the seals that include the bearded seals in the spring month of June…. When the river floods, near the mouth of Nigliq River it becomes filled with a hole or thin spot in [the] sea ice that has melted as the river breaks up. When it reaches the sea, that is the time that they begin to hunt for seals, through the thin spot in the sea ice that has melted. They hunt for bearded seals and other types of seals (USDOI, BLM, 1998).

Nuiqsut resident Ruth Nukapigak recounts past trips to this same sealing area: "I love to follow my son Jonah every year just when the ice begins moving down there and it takes us one hour travel time to get there. That is where we go to hunt for seals" (USDOI, BLM, 1998). Nuiqsut elder Samuel Kunaknana, when interviewed in 1979, noted that when the ice is nearshore in the summer, it is considered to be good for seal hunting (S. Kunaknana, as cited in Shapiro, Metzner, and Toovak, 1979). While seal meat is eaten, the dietary significance of seals primarily comes from seal oil, served with almost every meal that includes subsistence foods. Seal oil also is used as a preservative for meats, greens, and berries. Also, sealskins are important in the manufacture of clothing and, because of their beauty, spotted seal skins often are preferred for making boots, slippers, mitts, and parka trim. In practice, however, ringed seal skins are used more often in the making of clothing, because the harvest of this species is more abundant. A 1993 Department of Fish and Game subsistence survey in Nuiqsut indicates that 31.8% of the total subsistence harvest was marine mammals, and 3.1% of the total harvest was seals (State of Alaska, Dept. of Fish and Game, 1995a). George and Fuller (1997) estimated 24 ringed seals, 6 spotted seals, and 16 bearded seals were harvested in 1992, and the overall marine mammal contribution (including bowhead whales) to the total subsistence harvest was estimated at 36%. A subsistence-harvest survey conducted by the North Slope Borough, Division of Wildlife Management covering the period from July 1994-June 1995 reported a harvest of 23 ringed seals and a contribution of marine mammals of only 2% to the total subsistence harvest, primarily because no bowhead whales were harvested that season (Brower and Opie, 1997; Brower and Hepa 1998).

III.C.2.d(2)(e) Polar Bear

The harvest of polar bears by Nuiqsut hunters begins in mid-September and extends into late winter. Polar bear meat is sometimes eaten although little harvest data are available. One documented bear was harvested in the 1962-1982 period; for the period 1983-1995 Nuiqsut harvested 20 polar bears (Schliebe, 1995; State of Alaska, Dept. of Fish and Game, 1993, 1995a; Brower and Opie, 1997; Brower and Hepa, 1998). According to whaling captain Thomas Napageak's statement at the Beaufort Sea Sale 144 Public Hearings in Nuiqsut, the taking of polar bear is not very important now because Federal regulations prevent the selling of the hide: "...as valuable as it is, [it] goes to waste when we kill a polar bear" (USDOI, MMS, 1995a). Table III.C-14 shows polar bear harvests from 1983-1995 for Barrow, Nuiqsut, and Kaktovik.

III.C.2.d(2)(f) Beluga Whale

Some sources have mentioned beluga whales being taken incidentally during the bowhead harvest; however, Thomas Napageak, resident of Nuiqsut and Chairman of the Alaska Eskimo Whaling Commission, in recent testimony stressed that the village of Nuiqsut has never hunted beluga whales: "I don't recall a time when I went hunting for beluga whales. I've never seen a beluga whale here" (USDOI, BLM, 1998).

III.C.2.d(2)(g) Walrus

The Alaska Department of Fish and Game subsistence-survey data indicate that two walruses were harvested in the 1985/1986 harvest season, but no new walrus data for the community have been gathered since then (State of Alaska, Department of Fish and Game, 1993, 1995a). Walruses probably are incidentally taken during seal hunting.

III.C.2.d(2)(h) Moose

Moose normally are harvested from August-October by boat on the Colville (upriver from Nuiqsut), Chandler, and Itkillik rivers, but the timing for the harvest varies, depending on the current hunting regulations. Harvest data show that moose have been harvested during the winter months by snowmachine (Brower and Opie, 1997). In 1985, hunters from 40 households out of a total of 76 surveyed reported a harvest of seven moose (State of Alaska, Dept. of Fish and Game, 1993). In 1993, 62 households out of a total of 91 surveyed managed to harvest nine moose (State of Alaska, Dept. of Fish and Game, 1995a). A subsistence-harvest survey conducted by the North Slope Borough Division of Wildlife Management covering the period from July 1994 to June 1995 reported five moose harvested, or 5% of the total edible pounds harvested that season (Brower and Opie, 1997; Brower and Hepa, 1998). In 1992, caribou and moose accounted for 27% of the total subsistence harvest (George and Fuller, 1997); in 1993, moose and caribou accounted for 33% (Pedersen, 1996); and in the period covered by the North Slope Borough subsistence survey (July 1994 to June 1995), caribou and moose accounted for 63% of the edible pounds of subsistence resources harvested by Nuiqsut hunters (Brower and Opie, 1997; Brower and Hepa, 1998). This jump to a much higher percentage for terrestrial mammals is likely explained by an unsuccessful bowhead whale harvest during the study period (Suydam et al., 1994).

III.C.2.d(2)(i) Waterfowl

Waterfowl and coastal birds are a subsistence resource that has been growing in importance since the mid-1960's. Birds are harvested year-round, with peak harvests in May-June and September-October. The most important species for Nuiqsut hunters are the Canada and white-fronted goose and brant; eiders are harvested in low numbers. Ruth Nukapigak relates that "...when the white-fronted goose come, they do hunt them. When the thin ice near the mouth of the river breaks up, that is when they start duck hunting. We, the residents of Nuiqsut, go there to hunt for ducks when they arrive" (USDOI, BLM, 1998). The only upland bird hunted extensively is the ptarmigan (State of Alaska, Dept. of Fish and Game, 1993, 1995a; Brower and Opie, 1997). Recent data indicate that the subsistence bird harvest has provided 5% of the total harvest (Brower and Opie, 1997; Brower and Hepa, 1998). Waterfowl hunting occurs mostly in the spring, beginning in May, and continues throughout the summer. In the summer and early fall, such hunting usually occurs as an adjunct to other subsistence activities, such as checking fishnets.

Figures III.C-11 and III.C-12 indicate important trends in Nuiqsut household consumption of subsistence foods and expenditures on subsistence activities (Harcharek, 1995).

III.C.2.d(3) Kaktovik

Kaktovik is situated on Barter Island off the Beaufort Sea coast (population 224 in 1990, 230 in 1993, 256 in 1998, and 293 in 2000 [USDOC, Bureau of the Census, 1991, 2001; North Slope Borough, Dept. of Planning and Community Services, 1994, 1999]). For Kaktovik, the subsistence resources that could be affected by the Beaufort Sea sales are bowhead and beluga whales, seals, polar bears, caribou, fishes, and marine and coastal birds. The intensity of effort and preferred harvest periods are indicated in Figure III.C-14. A summary of subsistence resources harvested in 1992 can be seen in Table III.C-17. The North Slope Borough, Division of Wildlife Management, conducted a subsistence-harvest survey in Kaktovik covering the period from December 1994-November 1995. The survey recorded the subsistence-harvest effort for 73 households and the species types and numbers harvest for each month (see Tables III.C-18 and III.C-19; Brower, Olemaun, and Hepa, 2000). Like Nuiqsut, much of Kaktovik's marine subsistence-harvest area is within the proposed Beaufort Sea multiple-sale area, and the western edge of the community's terrestrial mammal, fish, and bird subsistence-harvest areas overlap a possible landfall location at Point Thompson.

III.C.2.d(3)(a) Bowhead Whale

Bowhead whaling occurs between late August and early October (Figure III.C-13), with the exact timing depending on ice and weather conditions. The whaling season can range anywhere from longer than 1 month to less than 2 weeks, depending on these conditions. As in Nuiqsut, Kaktovik whalers hunt the bowhead in the fall in aluminum skiffs in open water rather than in skin boats from the edge of ice leads. Whaling crews generally hunt bowheads within 10 miles of shore but occasionally may range as much as 20 miles from the coast (see Figures III.C-1 and III.C-14). Bowhead whales provide a large proportion of Kaktovik's subsistence harvest, but the number landed can vary and has ranged from zero to as many as four each year since 1962, with the exception of 1979 when five were landed (see Figure III.C-14 and 15). In the Department of Fish and Game 1992 subsistence harvest survey, bowhead whales amounted to 63% of the total subsistence harvest for the community, or 560.35 pounds per person (State of Alaska, Dept. of Fish and Game, 1993b; see Table III.C-17). Bowheads are an important meat resource and the source for maktak, an especially preferred food. The sharing of the bowhead is a central aspect of Kaktovik's Thanksgiving and Christmas feasts and the focus of the community's whale feast, Nalukataq. As in other North Slope communities, the bowhead is shared extensively. Its baleen is bartered in traditional networks and is used in the manufacture of traditional arts and crafts.

III.C.2.d(3)(b) Beluga Whale

Beluga whales usually are harvested in August through November (Figure III.C-14), incidental to the bowhead harvest. However, belugas sometimes are taken earlier in the open-water season when boating and camping groups are concentrating on the harvest of seals, caribou, or fish (Table III.C-17).

III.C.2.d(3)(c) Seals

Seals are hunted year-round, but the bulk of the seal harvest occurs during the open-water season from July to September (Figure III.C-13). Elder Elija Kakinya, when interviewed in 1979, stated that "when polar ice is not far from the barrier islands, is a good chance of catching seals when ice is close to shore" (in Shapiro and Metzner, 1979). During the winter, these harvests consist almost exclusively of ringed seals taken along open leads in the ocean ice many miles offshore. Summer harvests are made by boat crews and consist of ringed, bearded, and spotted seals (see Table III.C-19). Summer sealing typically occurs 5-10 miles offshore but may range up to 20 miles offshore (Figure III.C-1). Elder Bruce Nukapigak related how his father-in-law Uqumailaq taught him about hunting seals at Barter Island: "He took me on hunts as far as Cross Island and east of Barter Island to in front of the Jago River" (in Shapiro and Metzner, 1979).

Seal meat is eaten, and bearded seal meat is most preferred. However, the primary dietary significance of seals comes from seal oil, which is served with every meal that includes subsistence foods; seal oil is used, as well, as a preservative for meats, greens, and berries. Sealskins are important in the manufacture of clothing. Because of their beauty, spotted seal skins often are preferred for making boots, slippers, mitts, and parka trim, but ringed seal skins also are important in the manufacture of these same items. Bearded seal hides are necessary for the manufacture of boot soles. Sealskin products such as boots, slippers, mitts, and parkas are sold, bartered, and given as gifts to relatives and friends.

III.C.2.d(3)(d) Walrus

Walruses are harvested much less frequently than are seals in Kaktovik, because the community lies east of the mammal's optimum range. They are harvested only opportunistically by boat crews hunting other species in July and August (Figures III.C-1 and III.C-13). Harvests occur in open water along the coast in conjunction with seal hunting. Jacobson and Wentworth (1982) stated that in 1982, only five or six walruses had been harvested in the last two decades (see Table III.C-17). If harvested, walrus meat is eaten and its ivory used in the manufacture of traditional arts and crafts.

III.C.2.d(3)(e) Polar Bear

Polar bears are harvested during the winter months (Figure III.C-13) on ocean ice and along ocean leads. When discovered, these bears may be pursued seaward of the barrier islands for 10 miles or more. The meat often is consumed (see Table III.C-17). Since the passage of the Marine Mammal Protection Act in 1972, there has been less incentive for hunting polar bears, because the act made the sale of the unprocessed hides illegal (Jacobson and Wentworth, 1982). However, polar bear fur is still used to manufacture cold-weather gear such as boots, mitts, and coats. These sewn items are bartered, sold, and given as gifts to relatives and friends. Table III.C-14 shows polar bear harvests from 1983 to 1995 for Barrow, Nuiqsut, and Kaktovik.

III.C.2.d(3)(f) Caribou

Kaktovik harvests several large land mammals including caribou, Dall sheep, moose, and brown bear. Kaktovik's annual caribou harvest fluctuates widely because of the unpredictable movements of the Porcupine and Central Arctic herds, weather-dependent hunting technology, and ice conditions (see Figure III.C-1). Limited only by availability and unfavorable weather conditions, caribou can be harvested almost year-round (Figure III.C-13). With open water comes a period of intense caribou harvest that usually occurs in July. Kaktovik residents hunt caribou by boat along the coast, with hunting usually lasting until mid-August when the caribou move inland and are no longer abundant. Approximately 70% of all caribou harvests take place on the coastal plain. By late October, snow buildup allows hunters access to inland caribou. From then on, until the onset of breakup, which usually occurs sometime in May, Kaktovik hunters take caribou by snowmachine in inland mountains and valleys and, to a lesser extent, on the coastal plain. A subsistence-harvest survey conducted by the North Slope Borough Division of Wildlife Management covering the period from December 1994-November 1995 mapped terrestrial harvest locations for this seasonal round and are shown in Figure III.C-16 (Brower, Olemaun, and Hepa, 2000).

Caribou is eaten fresh, frozen, and dried and is the most preferred land mammal in Kaktovik's diet. During periods of high availability, caribou can be a source of fresh meat throughout the year. The meat often is shared with kin, friends, and elders within the community. Outside the community, caribou meat is sent to relatives as far away as Anchorage, and it occasionally is bartered. Caribou plays an important part in holiday feasts. Traditionally, the skins of caribou taken in July and August have been used to manufacture parkas, boot soles, mitts, and mukluk tops; blankets and sleeping pads are made from the skins of caribou taken in October and November.

In Pedersen and Coffing's (1985) 3-year study (1981-1983) of Kaktovik's caribou hunting, they found that the general caribou-hunting range covered about 7,600 square miles and that the intensely used area covered about 2,900 square miles. The latter figure is only a short-term measure of use intensity because the distribution and availability of caribou fluctuate over a period of years, and the size and location of the intensely used area also change. As expected from earlier research (North Slope Borough Contract Staff, 1979), harvest levels were highly variable. During the 1981-1982 season, 43 caribou were taken; during the 1982-1983 season, 110 were taken. The annual average harvest was 71.5, or approximately .4 caribou per capita. These figures indicated that the earlier State Department estimate of 100-300 caribou harvested per year by Kaktovik hunters might have been high (U.S. Department of State, 1980), until the 1992 the State of Alaska's subsistence harvest survey that recorded a take of 158 caribou that season (State of Alaska, Dept. of Fish and Game, 1993b). ACI and S.R. Braund and Assocs. (1984) estimated that an annual average of 75 caribou were taken by Kaktovik hunters between 1962 and 1983; and Jacobson and Wentworth (1982) estimated that 80 were taken in 1980. While Jacobson and Wentworth (1982) found high-yield areas in both coastal and inland habitats, 70% of all caribou harvests were found to take place on the coastal plain and near the coast. Most of these caribou were harvested by boat crews. For the most recent subsistence caribou harvest data, see Table III.C-19.

It should be noted that these figures cannot be extrapolated to apply to other North Slope communities, because species availability and use varies from settlement to settlement (North Slope Borough Contract Staff, 1979). For example, Kaktovik hunts the muskox, a big-game species unavailable to other North Slope communities. Kaktovik also is heavily dependent on fish (Jacobson and Wentworth, 1982). Moreover, these figures cannot be assumed to reflect the long-term per capita harvests made by Kaktovik hunters. Pederson and Coffing conducted their work in the early 1980's, a period of intense Capital Improvement Project construction, and reports from other North Slope communities during this time indicated that subsistence hunting may have dropped because of Capital Improvement Project wage employment; more recent data tends to indicate an increase in subsistence hunting since the drop in availability of wage work. Additionally, it was discovered that, even in the early 1980's, Kaktovik's hunting patterns already may have been affected by industrialization. Pedersen and Coffing (1985) wrote:

> A sizable portion of the general caribou hunting range, as well as a portion of the intensively used area, has been identified as lying within a rapidly industrializing portion of the east-central North Slope. However, very little caribou hunting activity has been conducted in the area recently by Kaktovik residents.

It was suggested that unclear harvesting regulations in addition to industrialization may have led to avoidance of this region by Kaktovik caribou hunters.

III.C.2.d(3)(g) Dall Sheep

Although not a major subsistence resource in terms of pounds harvested, Dall sheep are the most preferred subsistence resource by Kaktovik hunters. With difficulties the availability of musk ox-permits and the variability of caribou as a summer subsistence meat source, sheep might be one of the more stable meat sources available to the community. Sheep are hunted by snowmachine from late October through November and in the spring from March through April. The preferred hunting period is in the fall when the sheep have more fat. See Table III.C-19 for recent subsistence-harvest numbers for sheep (Impact Assessment, Inc., 1990d; State of Alaska, Dept. of Fish and Game 1993b).

III.C.2.d(3)(h) Muskox

In 1969, the Department of Fish and Game, with the assistance of the Fish and Wildlife Service, reintroduced muskoxen into the Kaktovik area. Originally indigenous, the muskox was extinct by the late 1800s, probably hunted out by non-Native hunters. Not until 1983 was a hunt permitted, and then only by a limited permit drawing and the payment of a large permit fee. From 1986-1989, permitting problems prevailed. Seven permits presently are reserved for a sport-hunt drawing in Fairbanks, and seven are allocated for local Kaktovik hunters. Muskoxen are hunted in March and April when the days are long and travel by snowmachine still good. The hunt is conducted in the Camden Bay area and in the Sadlerochit River drainage. See Table III.C-19 for muskox-harvest numbers.

III.C.2.d(3)(i) Fishes

Fish is an important subsistence resource for Kaktovik. The community's harvest of most other subsistence resources can fluctuate widely from year to year because of variable migration patterns of game and because harvesting technologies are extremely dependent on ice conditions and weather, but the harvest of fish is not subject to these conditions, and this adds to their importance in Kaktovik's subsistence system. Moreover, in January and February, fish may provide the only source of fresh subsistence foods (see Figure III.C-13). In the summer, Kaktovik residents primarily harvest arctic char. Sea-run char are caught all along the coast, around the barrier islands, and up the navigable portions of the river deltas. Char are the first fish to appear after the ice is gone in early July and are caught until late August. Arctic cisco are harvested in the ocean after the arctic char run peaks, beginning about the first of August through early September. Grayling is a major subsistence fish taken in the Hulahula River and in many other area rivers and river deltas. Late summer, after freezeup, and again in the spring, are the most likely times to catch grayling. Least cisco is taken in the lagoons, river deltas, and particularly the small lakes and streams of the river drainages. Broad whitefish is harvested in the deeper lakes and channels of the Canning River Delta from July through September. Less commonly harvested are round whitefish, also harvested in the Canning River, and pink and chum salmon are occasionally taken in July and August near Barter Island (Jacobsen and Wentworth, 1982). See Table III.C-17 for more recent data on Kaktovik's subsistence harvests of fishes.

Arctic flounder and fourhorn sculpin occasionally are taken during summer ocean fishing off Manning Point, Drum Island, Arey Spit, and in Kaktovik Lagoon between Manning Point and the mainland; but sculpin often is not eaten because it is too bony. Called Paigluk in Inupiaq, pike (not yet positively identified) is caught in the Hulahula River and occasionally in other rivers. Arctic cod or Tom cod and smelt are caught in the summer along the Beaufort Sea coast, sometimes near the spits off Barter Island. Blackfish is harvested in the spring in the Canning, Hulahula, Kongakut, and, especially, the Aichilik rivers (Jacobsen and Wentworth, 1982).

During the fall/winter fish harvest, freshwater arctic char is taken inland on the rivers by fishing through holes in the ice. Broad whitefish occasionally is taken in the winter at fishing holes farther inland on the Canning River. Small numbers of ling cod are sometimes taken inland on the Canning River during the snow season. They are harvested only on the inland portions of rivers, at least 10 miles from the coast. During winter, lake trout are caught in the Neruokpuk Lakes of the Brooks Range. Tom cod and smelt are sometimes caught by jigging in October and November north of Barter Island and at Iglukpaluk. Blackfish is harvested in the winter in the Canning, Hulahula, and Kongakut rivers, with harvests in the Aichilik River the most productive (Jacobsen and Wentworth, 1982).

Because of the important role of fish as an abundant and stable source of fresh food during midwinter months, it is shared at Thanksgiving and Christmas feasts, as well as given to relatives, friends, and village elders. Subsistence uses in Kaktovik are similar to those found elsewhere on the North Slope, where fish figures in existing traditional sharing and bartering networks of the communities.

III.C.2.d(3)(j) Waterfowl

Since the mid-1960's, waterfowl and coastal birds as a subsistence resource have been growing in importance. The most important subsistence species of birds for Kaktovik are the black brant, long-tailed duck, eiders, snow goose, Canada goose, and pintail duck. Other birds, such as loons, occasionally are harvested. Waterfowl hunting occurs mostly in the spring, from May through early July (Figure III.C-13); normally, a less-intensive harvest continues throughout the summer and into September. During spring, birds are harvested by groups of hunters that camp along the coast, with spits and points of land providing the best hunting locations. Kaktovik's primary subsistence-harvest areas for waterfowl are shown in Figure III.C-1. In summer and early fall, bird hunting occurs as an adjunct to other subsistence activities, such as checking fishing nets.

Virtually the entire community of Kaktovik participates in the spring bird hunt. The hunt occurs at the end of the school year and has become a major family activity. Because waterfowl is a highly preferred food, it is shared extensively within the community, and birds are given to relatives, friends, and village elders. While most birds are eaten fresh, usually in soup, some are stored for the winter. Waterfowl is served for special occasions and holiday feasts such as Nalukataq and Thanksgiving, and occasionally birds are bartered. Table III.C-19 shows subsistence bird-harvest data for household subsistence surveys conducted in 1987 and 1992 by the State of Alaska, Dept. of Fish and Game (1993a,b).

Figures III.C-17 and III.C-18 indicate important trends in Kaktovik household consumption of subsistence foods and expenditures on subsistence activities (Harcharek, 1995).

III.C.3. Sociocultural Systems

The topic of sociocultural systems encompasses the social organization and cultural values of a society. This section provides a profile of the sociocultural systems that characterize the North Slope communities of Barrow, Nuiqsut, and Kaktovik, whose ethnic, sociocultural, and socioeconomic makeup is primarily Inupiaq.

The communities of Barrow, Nuiqsut, and Kaktovik potentially could be affected by exploration and development in the project area. Their populations and current socioeconomic conditions are discussed before the important variables in a sociocultural analysis—social organization, cultural values, institutional organization, and other ongoing issues—are considered.

The following summarizes and incorporates by reference detailed descriptions of sociocultural systems found in the Beaufort Sea Sale 144 final EIS (USDOI, MMS, 1996a), the Northeast National Petroleum Reserve-Alaska Draft Integrated Activity Plan/EIS (USDOI, Bureau of Land Management and MMS, 1998), the Beaufort Sea Sale 170 final EIS (USDOI, MMS, 1998), and the Beaufort Sea Oil and Gas Development Project/ Northstar draft EIS (U.S. Army Corps of Engineers, 1998). This summary is augmented by additional material, as cited. Sociocultural systems of the North Slope Inupiat also are described and discussed in the Beaufort Sea Sale 97 final EIS (USDOI, MMS, 1987), the Chukchi Sea Sale 109 final EIS (USDOI, MMS, Alaska OCS Region, 1987), and the Beaufort Sea Sale 124 final EIS (USDOI, MMS, 1990a). The following description is augmented by information from current studies, including State of Alaska, Department of Fish and Game (1996, 2002); State of Alaska, Department of Community and Regional Affairs/Community and Borough Map (1996); Fall and Utermohle (1995); S.R. Braund and Assocs. and UAA, ISER (1993); S.R. Braund and Assocs. (In prep.); Alaska Natives Commission (1994); City of Nuiqsut (1995); Human Relations Area Files, Inc. (1994); USDOI, MMS (1996b,c); Hoffman, Libbey, and Spearman (1988); Schneider, Pedersen, and Libbey (1980); and the USDOI, Bureau of Land Management's National Petroleum Reserve-Alaska 105(c) studies and other pertinent documents that accompanied the 105(c) analysis (USDOI, Bureau of Land Management, 1978a,b,c; 1979b,c,d; 1981; 1982a,b,c; 1983a,b,c; 1990; and 1991).

III.C.3.a. Characteristics of the Population

The North Slope has a fairly homogeneous population of Inupiat, approximately 72% in 1990 and 68.38% in 2000, although Indians and Alaskan Natives were not differentiated in the 2000 count. These percentages are approximations, because the 1990 and 2000 censuses did not distinguish between Inupiat and other Alaskan Natives and American Indians. The percentage in 1990 ranged from 92.7% Inupiat in Nuiqsut to 61.8% Inupiat in Barrow (USDOC, Bureau of the Census, 1991). The percentage in 2000 ranged from 89.1% Inupiat in Nuiqsut to 64.0% Inupiat in Barrow (USDOC, Bureau of the Census, 2001). In 2000, population counts were 4,581 for Barrow, 433 for Nuiqsut, and 293 for Kaktovik (USDOC, Bureau of the Census, 2001).

North Slope society responded to early contacts with outsiders by successfully changing and adjusting to new demands and opportunities (Burch, 1975a,b; Worl, 1978; North Slope Borough Contract Staff, 1979). Since the 1960's, the North Slope has witnessed a period of "super change," a pace of change quickened by the area's oil developments (Lowenstein, 1981). In the Prudhoe Bay/Kuparuk industrial complex, oil-related work camps have altered the seascape and landscape, making some areas off limits to traditional subsistence hunting. In addition, large North Slope Borough Capital Improvement Projects have dramatically changed the physical appearance of North Slope Borough communities.

Social services have increased dramatically since 1970, with increased Borough budgets and grants acquired early on by the Inupiat Community of the Arctic Slope, and later by the Arctic Slope Native Association and other borough nonprofits. In 1970 and 1977, residents of North Slope villages were asked about their state of well-being in a survey conducted by the University of Alaska, Anchorage, Institute of Social and Economic Research (Kruse et al., 1983). The survey noted significant increases in complaints about alcohol and drug use in all villages between 1970 and 1977. Health and social-services programs have attempted to address these problems with treatment programs and shelters for wives and families of abusive spouses, as well as putting greater emphasis on recreational programs and services. More recently, a lack of adequate financing for individual North Slope Borough city governments has hampered the development of these programs, and declining revenues from the State of Alaska have seriously impaired the overall function of these city governments. In the last decade, all communities in the North Slope Borough have struggled with banning the sale, use, and possession of alcohol, and the issue of whether a community will become "dry" or stay "wet" is constantly being brought before local voters.

The introduction of modern technology has tied the Inupiat subsistence economy increasingly to a cash economy (Kruse, 1982). Nevertheless, oil-supported revenues have been able to support a lifestyle that still is distinctly Inupiaq and outside pressures and opportunities have sparked what may be viewed as a cultural revival (Lantis, 1973). What exists in the communities of the North Slope is "a unique lifestyle in which a modern cash economy and traditional subsistence are interwoven and interdependent" (USDOI, Bureau of Land Management, 1979). People continue to hunt and fish, but aluminum boats, outboards, snowmachines, and all-terrain vehicles now blend these pursuits with wage work. Inupiat whale hunting remains a proud tradition that involves ceremonies, dancing, singing, visiting, cooperation between communities and, most important, the sharing of foods.

North Slope residents exhibit an increasing commitment to areawide political representation, local and regional tribal governments, and the cultural preservation of such institutions as whaling crews and dancing organizations, and the revival of traditional seasonal celebrations. The North Slope Borough has a Commission on Inupiat History, Language and Culture, an important body for preserving Inupiat heritage, for conducting elders' conferences and other cultural activities to preserve oral histories, and to actively pursue the repatriation of cultural artifacts and remains under the Native American Graves Protection and Repatriation Act. Effects from ongoing and proposed oil exploration and development on subsistence and, hence, on the overall sociocultural system, have been, are, and will continue to be a major concern for residents of North Slope communities (Kruse et al., 1983; ACI and S.R. Braund and Assocs., 1984; USDOI, MMS, 1994, 1995b, 1996a; S.R. Braund and Assocs., In prep.; USDOI, Bureau of Land Management, 1997c; USDOI, MMS, 1998).

III.C.3.b. Social Characteristics of the Communities

The following describes the Alaskan North Slope communities that may be affected directly by exploration and development in the planning area. These community-specific descriptions discuss factors relevant to the sociocultural analysis of the community in relation to industrial activities, population, and current socioeconomic conditions. Following these descriptions, social organization, cultural values, and other issues of all the communities are discussed. MMS' ongoing *Quantitative Description of Potential Effects of OCS Activities on Bowhead Whale Hunting Subsistence Activities in the Beaufort Sea* study was developed in response to concerns raised by the Alaska Eskimo Whaling Commission and the North Slope Borough. This study will involve a systematic analysis of residents' observations and perceptions about how their lives, and especially subsistence whale hunting activities, have been and might in the future be affected by oil-industry activities and other forces of modernity.

III.C.3.b(1) Socioeconomic Conditions in Barrow

On the North Slope, Barrow is the largest community and the regional center. Barrow's population in 2000 was 4,581 (USDOC, Bureau of the Census, 2001). Barrow already has experienced dramatic population changes as a result of increased revenues from onshore oil development and production at Prudhoe Bay and in other smaller oil fields; these revenues early on served to stimulate the North Slope Borough Capital Improvement Projects. In 1970, the Inupiat population of Barrow represented 91% of the total population (USDOC, Bureau of the Census, 1971). In 1985, non-Natives outnumbered Natives between the ages of 26 and 59 (North Slope Borough, Dept. of Planning and Community Services, 1989). By 1990, Inupiat representation had dropped to 63.9%, but in the 2000 Census, Barrow's Inupiat population remained undiminished at 64.0% (USDOC, Bureau of the Census, 1991, 2001; Harcharek, 1992). Most of Barrow's terrestrial and marine subsistence-harvest area lies in or adjacent to the Beaufort Sea multiple-sale area.

From 1975-1985, Barrow experienced extensive social and economic transformations. The North Slope Borough Capital Improvement Projects stimulated a boom in the Barrow economy and an influx of non-Natives to the community; between 1980 and 1985, Barrow's population grew by 35.6% (Kevin Waring Assocs., 1989). Inupiat women entered the labor force in the largest numbers ever and achieved positions of political leadership in newly formed institutions. The proportion of Inupiat women raising families without husbands also increased during this period, a noticeable alteration in a culture where the extended family, operating through interrelated households, is salient in community social organization (Worl and Smythe, 1986). During this same period, the social organization of the community became increasingly diversified with the proliferation of formal institutions and the large increase in the number of different ethnic groups, although socioeconomic differentiation is not new in Barrow. During the periods of commercial whaling and reindeer herding, there were influxes of outsiders and significant shifts in the economy. Other fluctuations have occurred during different economic cycles: fur trapping, U.S. Navy and arctic contractors' employment, the Capital Improvement Projects' boom, and periods of downturn (Worl and Smythe, 1986). As a consequence of the changes it already has sustained, Barrow may be more capable of absorbing additional changes as a result of oil exploration and development than would smaller, homogenous Inupiat communities such as Nuiqsut and Kaktovik.

III.C.3.b(2) Socioeconomic Conditions in Nuiqsut

Nuiqsut is located on the west bank of the Nechelik Channel of the Colville River Delta, about 25 miles from the Arctic Ocean and approximately 150 miles southeast of Barrow. The population was 354 (92.7% Inupiat) in 1990 and 433 (89.1% Inupiat) in 2000 (USDOC, Bureau of the Census, 1991, 2001). Nuiqsut, one of three abandoned Inupiat villages in the North Slope region identified in the Alaska Native Claims Settlement Act, was resettled in 1973 by 27 families from Barrow. Today, Nuiqsut is experiencing rapid social and economic change with a new hotel, the influx of non-Inupiat oil workers at the Alpine field adjacent to the community, and the potential development of oil in the National Petroleum Reserve-Alaska.

Most of Nuiqsut's marine subsistence-harvest area lies adjacent to the Beaufort Sea multiple-sale area. Nuiqsut's important bowhead whale hunting area at Cross Island is nearshore of the sale-area boundary, but hunters from the island would pursue whales well within the multiple-sale area. Nuiqsut's terrestrial, fish, and bird subsistence-harvest areas are in the vicinity of possible new landfalls. Any pipelines from these landfalls potentially would cross Nuiqsut's land subsistence-harvest area.

III.C.3.b(3) Socioeconomic Conditions in Kaktovik

Kaktovik, incorporated in 1971, is the easternmost village in the North Slope Borough. In 1990, it had a population of 224 (83% Inupiat) and in 2000 it had a population of 293 (84.0% Inupiat) (USDOC, Bureau of the Census, 1991, 2001). Kaktovik is located on the north shore of Barter Island, situated between the Okpilak and Jago rivers on the Beaufort Sea coast. Barter Island is one of the largest of a series of barrier islands along the north coast and is about 300 miles east of Barrow. Kaktovik's coastal and marine subsistence-harvest areas are in and adjacent to the Beaufort Sea multiple-sale area. Its terrestrial mammal, fish, and bird subsistence-harvest areas lie adjacent to the sale area. Kaktovik has been an important "place of barter" for centuries. Canadian and Barrow Inupiat stopped on Barter Island to trade. In 1923, the white trader, Tom Gordon, established a store at Barter Island that provided a permanent location for resident trappers for trading furs and gaining supplies. With the introduction of reindeer to the area in the 1920's, the settlement slowly grew into a permanent village (Kevin Waring Assocs., 1989).

III.C.3.c. Social Organization

The social organization of these Inupiat communities is strongly kinship oriented. Kinship forms “the axis on which the whole social world turn[s]” (Burch, 1975a,b). Historically, households were composed of large, extended families, and communities were kinship units. Today, there is a trend away from the extended-family household because of increases in mobility, availability of housing, and changes in traditional kinship patterns. However, kinship ties in Inupiat society continue to be important and remain a central focus of social organization.

The social organization of North Slope Inupiat encompasses not only households and families but also wider networks of kinspeople and friends. These various types of networks are related through various overlapping memberships and also are embedded in those groups that are responsible for hunting, distributing, and consuming subsistence resources (Burch, 1970). An Inupiat household on the North Slope may contain a single individual or group of individuals who are related by marriage or ancestry. The interdependencies that exist among Inupiat households differ markedly from those found in the United States as a whole. In the larger, non-Inupiat society, the demands of wage work emphasize a mobile and prompt workforce. While modern transportation and communication technologies allow for contact among parents, children, brothers, sisters, and other extended-family members, more often than not, independent nuclear households (father, mother, and children) or conjugal pairs (childless couples) form independent “production” units that do not depend on extended-family members for the day-to-day support of food, labor, or income. A key contrast between non-Native and Inupiat cultures occurs in their differing expectations of families—the Inupiat expect and need support from extended-family members on a day-to-day basis.

Associated with these differences, the Inupiat hold unique norms and expectations about sharing. Households are not necessarily viewed as independent economic units; and giving, especially by successful hunters in the community, is regarded as an end in itself although community status and esteem accrue to the generous. Kinship ties are strengthened through the sharing and exchanging of subsistence resources (Nelson, 1969; Burch, 1971; Worl, 1979; ACI, Courtnage, and Braund, 1984; Luton, 1985; Chance, 1990).

III.C.3.d. Cultural Values

Traditionally, Inupiat values focused on their close relationship with natural resources, specifically game animals. The Inupiat also had a close relationship to the supernatural with specific beliefs in animal souls and beings who control the movements of animals. Other values included an emphasis on the community, its needs, and its support of other individuals. The Inupiat respect persons who are generous, cooperative, hospitable, humorous, patient, modest, and industrious (Lantis, 1959; Milan, 1964; Chance, 1966, 1990). Although there have been substantial social, economic, and technological changes in Inupiat lifestyle, subsistence continues to be the central organizing value of Inupiat sociocultural systems. The Inupiat remain socially, economically, and ideologically loyal to their subsistence heritage. Indeed, “most Inupiat still consider themselves primarily hunters and fishermen” (Nelson, 1969). This refrain is voiced repeatedly by the residents of the North Slope (Kruse et al., 1983; ACI, Courtnage, and Braund, 1984; Impact Assessment, Inc., 1990a,b; USDOI, MMS, 1994). Task groups still are organized to hunt, gather, and process subsistence foods. Cooperation in hunting and fishing activities also remains an integral part of Inupiat life, and who one cooperates with is a major component of the definition of significant kin ties (Heinrich, 1963). Large amounts of subsistence foods are shared within the community, and who one gives to and receives from also are major components of what makes up significant kin ties (Heinrich, 1963; ACI, Courtnage, and Braund, 1984).

On the North Slope, “subsistence” is much more than an economic system. The hunt, the sharing of the products of the hunt, and the beliefs surrounding the hunt tie families and communities together, connect people to their social and ecological surroundings, link them to their past, and provide meaning for the present. Generous hunters are considered good men, and good hunters often are respected leaders. Good health comes from a diet derived from the subsistence hunt. Young hunters still give their first game to the community elders, and to be generous brings future success. These are some of the essential ways that subsistence and beliefs about subsistence join with sociocultural systems.

The cultural value placed on kinship and family relationships is apparent in the sharing, cooperation, and subsistence activities that occur in Inupiat society; however, cultural value also is apparent in the patterns of residence, reciprocal activities, social interaction, adoption, political affiliations (some families will dominate one type of government administration, for example, the village corporation), employment, sports activities, and membership in voluntary organizations (Mother's Club, Search and Rescue, etc.) (ACI, Courtnage, and Braund, 1984).

Bowhead whale hunting remains at the center of Inupiat spiritual and emotional life; it embodies the values of sharing, association, leadership, kinship, arctic survival, and hunting prowess (see Bockstoce et al., 1979; ACI, Courtnage, and Braund, 1984). Barrow resident Beverly Hugo, testifying at public hearings for MMS' Beaufort Sea Sale 124, summed up Inupiaq cultural values this way:

> …these are values that are real important to us, to me; this is what makes me who I am…the knowledge of the language, our Inupiat language, is a real high one; sharing with others, respect for others…and cooperation; and respect for elders; love for children; hard work; knowledge of our family tree; avoiding conflict; respect for nature; spirituality; humor; our family roles. Hunter success is a big one, and domestic skills, responsibility to our tribe, humility…these are some of the values…that we have…that make us who we are, and these values have coexisted for thousands of years, and they are good values…(USDOI, MMS, 1990b).

The importance of the whale hunt is more than emotional and spiritual. The organization of the crews does much to delineate important social and kin ties within communities and also to define community leadership patterns. The structured sharing of the whale helps determine social relations both within and between communities (Worl, 1979; ACI, Courtnage, and Braund, 1984; Impact Assessment, Inc., 1990a). Structured sharing also holds true for caribou hunting, fishing, and other subsistence pursuits. In these communities, the giving of meat to elders does more than feed old people; it bonds giver and receiver, joins them to a living tradition, and draws the community together.

Today, this close relationship between the spirit of a people, their social organization, and the cultural value of subsistence hunting may be unparalleled when compared with other areas in America where energy-development is taking place. The Inupiat's continuing strong dependence on subsistence foods, particularly marine mammals and caribou, creates a unique set of potential effects from onshore and offshore oil exploration and development on the social and cultural system. Barrow resident Daniel Leavitt articulated these concerns during a 1990 public hearing for Beaufort Sea Sale 124: "…as I have lived in my Inupiat way of livelihood, that's the only…thing that drives me on is to get something for my family to fill up their stomachs from what I catch" (USDOI, MMS, 1990b).

One analysis of Inupiat concerns about oil development was based on a compilation of approximately 10 years of recorded testimony at North Slope public hearings for State and Federal energy-development projects. The most concerns centered on the subsistence use of resources, including damage to subsistence species, loss of access to subsistence areas, loss of Native foods, or interruption of subsistence-species migration. These four concerns represented the concerns expressed in 83% of all the testimony taken on the North Slope (Kruse et al., 1983:Table 35; USDOI, MMS, 1994; Human Relations Area Files, Inc., 1992).

Another great concern that North Slope Borough Inupiat communities express is the lack of traditional knowledge and testimony appearing in government documents, particularly MMS's oil lease-sale EIS's. Mayor George N. Ahmaogak, Sr., of the North Slope Borough said in a 1990 letter to MMS: "The elders who spoke particularly deserve a response to their concerns. You should respect the fact that no one knows this environment better than Inupiat residents" (Ahmaogak, 1990, pers. commun.). In public testimony in 1993 concerning a Letter of Authorization for bowhead whale monitoring at the Kuvlum Prospect, the late Burton Rexford, then Chairman of the Alaska Eskimo Whaling Commission, stated that the most important environmental information would come from whaling captains, crew members, and whaling captains' wives. "We know our environment—our land and resources—at a deep level" (National Marine Fisheries Service, 1993). These same concerns were unanimously echoed by those testifying for Barrow, Kaktovik, and Nuiqsut in hearings and scoping meetings for Beaufort Sea Sales 144 and 170, for the National Petroleum Reserve-Alaska Management Plan, for the Northstar and Liberty projects, and for the Beaufort Sea multiple sales (Public Hearing Transcripts, Beaufort Sea Sale 144 [USDOI, MMS, 1995a,b,c], Beaufort Sea Sale 170 [USDOI, MMS, 1997], National Petroleum Reserve-Alaska Integrated Activity Plan Draft

EIS [USDOI, Bureau of Land Management and MMS, 1997], Beaufort Sea Oil and Gas Development Project/Northstar [U.S. Army Corps of Engineers, 1996], and the Liberty Project Scoping Meeting [USDOI, MMS, Alaska OCS Region, 1998b]).

At scoping meetings for all six of these projects, the need to address cumulative impacts was stressed repeatedly, mainly because impacts from development already have reduced subsistence access to and use of the area around Prudhoe Bay. The point was made at each meeting that incremental development in and around Prudhoe Bay has created cumulative impacts. Development impacts can be assessed only through a viable monitoring regime—something that has never been established by the industry or the Federal and State agencies involved. One suggestion that was made repeatedly and reiterated again at the National Petroleum Reserve-Alaska Symposium (USDOI, Bureau of Land Management and MMS, 1997) was a need for an ongoing subsistence-oversight panel composed of Federal, State, Native, and oil-industry interests that would address these concerns and the need for instituting an ongoing subsistence-monitoring program.

III.C.3.e. Institutional Organization of the Communities

The North Slope Borough provides most government services for the communities of Barrow, Nuiqsut, Kaktovik, and other communities in the Borough. These services include public safety, public utilities, fire protection, and some public-health services. Future fiscal and institutional growth is expected to slow because of economic constraints on direct Inupiat participation in oil-industry employment and growing constraints on the Statewide budget. Although the North Slope Borough's own permanent fund account continues to grow as does its role as primary employer in the region, Borough tax revenues are decreasing (Kruse et al., 1983; Harcharek, 1992, 1995). The Arctic Slope Regional Corporation, formed under the Alaska Native Claims Settlement Act, runs several subsidiary corporations. Most of the communities also have a village corporation, a Traditional Village or Indian Reorganization Act Village Council, and a city government. The Indian Reorganization Act and village governments have not provided much in the way of services, but village corporations have made many service contributions. The Inupiat Community of the Arctic Slope, the regional tribal government, recently has taken on a more active and visible role in regional governance.

III.C.3.f. Other Ongoing Issues

Other issues important to an analysis of sociocultural systems are those that will affect or already are affecting Inupiat society (i.e., cumulative impacts). The EIS's for MMS Sales 97, 124, 144, 170; the Northstar and Liberty projects; and the National Petroleum Reserve-Alaska detail issues about changes in employment, increases in income, decreases in Inupiaq fluency, rising crime rates, and substance abuse (USDOI, MMS, 1987, 1990a, 1996a, 1998; USDOI, MMS, Alaska OCS Region, 2002a; USDOI, Bureau of Land Management and MMS, 1998; U.S. Army Corps of Engineers, 1996) and also discuss the fiscal and institutional growth of the North Slope Borough. These discussions are incorporated by reference and summarized briefly below. In addition, Smythe and Worl (1985) and Impact Assessment, Inc. (1990a) detail the growth and responsibilities of local governments.

Recent statistics on homicides, rapes, and wife and child abuse present a sobering picture of some aspects of life in North Slope Borough communities. Violent deaths account for more than one-third of all deaths on the North Slope. The Alaska Native Health Board notes the "overwhelming involvement of alcohol (and drug) abuse in domestic violence, suicide, child abuse, birth defects, accidents, sexual assaults, homicide and mental illness" (Alaska Native Health Board, 1985). The lack of comparable data makes it impossible to compare levels of abuse and violence between aboriginal (prior to contact with Caucasians), traditional (from the time of commercial whaling through the fur trade), and modern (since World War II) Inupiat populations. Nonetheless, it is apparent from reading earlier accounts of Inupiat society that there has been a drastic increase in these social problems, although a study conducted in the early 1980's on the North Slope indicates that no direct relationship was found between energy development and "accelerated social disorganization" (Kruse, Kleinfeld, and Travis, 1982, cited in Impact Assessment, Inc., 1990b).

Studies done in Barrow (Worl and Smythe, 1986) detail the important changes in Inupiat society that have occurred during the last decade in response to these problems. Services provided by outside institutions and programs recently have begun to assume a greater responsibility for functions formerly provided by extended families. Today, there is an array of social services available in Barrow that is more extensive for a community of this size than anywhere in the U.S. (Worl and Smythe, 1986).

The baseline of the present sociocultural system includes change and strain. The very livelihood and culture of North Slope residents come under increasingly close scrutiny, regulation, and incremental alteration. Increased stresses on social well-being and on cultural integrity and cohesion come at a time of relative economic well-being. The expected challenges on the culture by the decline in Capital Improvement Project funding from the State of Alaska have not been as significant as once expected. The buffer effect has come mostly through the dramatic growth of the Borough’s own permanent fund, the North Slope Borough taking on more of the burden of its own capital improvement, and its emergence as the largest employer of local residents. However, North Slope Borough revenues from oil development at Prudhoe Bay are on the decline, and funding challenges (and subsequent challenges to the culture) continue as the Alaska State Legislature alters accepted formulas for Borough bonding and for funding rural school districts.

III.C.4. Archaeological Resources

Archaeological Resource means “any material remains of human life or activities that are at least 50 years of age and that are of archaeological interest.” Archaeological Interest means “capable of providing scientific or humanistic understanding of past human behavior, cultural adaptation, and related topics through the application of scientific or scholarly techniques, such as controlled observation, contextual measurement, controlled collection, analysis, interpretation and explanation. These resources provide information pertaining to history or prehistory. It is the policy of the MMS to consider the effects on archaeological resources in all aspects of planning, leasing, permitting, operations, and regulatory decisions. To do this, an assessment of archaeological resource potential within the area to be affected by a proposed action must take place (MMS Manual Part 620.1.1).

The National Register of Historic Places is a national inventory of sites that meet specific criteria of significance. Most archaeological sites listed on or eligible for the Register meet Criterion D, Information Potential: “Properties may be eligible for the National Register if they have yielded, or may be likely to yield, information important in prehistory or history. With rare exception, properties must be 50 or more years old to be considered eligible for the National Register” (USDOI, National Register Bulletin No. 15).

In the case of the Federal OCS, most of the Beaufort Sea Planning Area has never been surveyed for archaeological sites; and no sites on the OCS have been listed on the National Register. Therefore, archaeological resources or potential resources within the planning area must be identified using regional baseline studies that are predictive models, geophysical/geological data, historic accounts of shipwreck disasters, and marine remote-sensing data compiled from required shallow-hazards surveys.

The following analyses represent the Prehistoric Resource Analysis and Shipwreck Update Analysis required in the MMS Handbook for Archaeological Resource Protection (620.1-H). We incorporate by reference the archaeological analyses prepared for previous Beaufort Sea lease sales and previous works concerning the geologic processes that affect the survivability of potential prehistoric sites. Wherever appropriate, these sources have been updated with current reports, surveys, and information.

III.C.4.a. Prehistoric Resources

Prehistoric resources “pertain to that period of time before written history. In North America, ‘prehistoric’ usually refers to the period before European contact” (MMS Manual 620.1-H).

III.C.4.a(1) Onshore

A review of the Alaska Heritage Resources Survey site files indicates that 18 sites with prehistoric components have been recorded in the Beaufort Sea Planning Area (see Table III.C-20). They are comprised of habitation sites, lithic scatters, and isolated finds.

III.C.4.a(2) Offshore

The potential for submerged prehistoric sites in the Beaufort Sea Planning Area was determined by an evaluation of the available geophysical/geological and archaeological data. This analysis was prepared to aid in the identification of lease blocks with prehistoric-site potential. The geologic processes that have acted on the ocean floor of the sale area are summarized in Section III.A.1 and have been evaluated with regard to the distribution, survivability, and detectability of potential archaeological resources sites. The current multiple-sale area includes lease blocks previously offered in the following Beaufort Sea lease sales: the Joint Federal/State Beaufort Sale, Diapir Field Sale 71, Sale 87, Sale 97, Sale 124, Sale 144, and Sale 170.

Archaeological analyses were prepared for previous Beaufort Sea lease sales and are cited by reference in this report. However, the baseline study of Friedman and Schneider (1987) concerning the geomorphological processes that pertain to the survivability of potential prehistoric resource sites in the sale area is updated with current reports, surveys, and information pertinent to this analysis. The Friedman and Schneider report (USDOI, MMS, 1987) recommended that all blocks in the Beaufort Sea sale area be exempted from prehistoric resource requirements. Those conclusions are modified in the present report.

The last two EIS's published (Sales 144 and 170) found that there is only low potential for archaeological resources in the Beaufort Sea Planning area. Since then, it has come to our attention during the analysis of site conditions of several wells in the shallow-water inner shelf (Warthog #1, Liberty #1, the proposed Liberty Development area, and the McCovey exploration site) that there are several potential conditions that, in combination with other features, properties, or environments, might cause the archaeological potential for an area to increase (USDOI, MMS, Alaska OCS Region, 2002a:Section VI.B.3).

These conditions are found in the following:

- Areas of no ice gouging, which allows the potential preservation of terrestrial sediments and landforms. These areas have been found inside barrier islands and in other areas where there is stable, floating shorefast ice.
- The presence of in situ Quaternary terrestrial sediments such as peat, soil horizons, and river-bar and -bank deposits.
- The presence of submerged and buried terrestrial landforms.

In previous EIS evaluations, we assumed that ice gouging and coastal and marine erosional processes had destroyed or severely disturbed drowned late Pleistocene to Holocene landforms and terrestrial sediments, virtually eliminating the possibility of in situ archaeological resources. We now believe that in areas with little or no ice gouging, the possibility exists for undisturbed, potential prehistoric archaeological resources. These areas of little or no ice gouging correspond to the areas of stable, shorefast floating ice, shoreward of the stamukhi zone, and areas shoreward of the barrier islands.

The following individual blocks have been identified as having the potential for prehistoric archaeological resources:

- OPD: NR 05-01, Dease Inlet; Blocks: 6604-6606, 6654-6657, 6704-6709, 6754-6761, 6804-6812, 6856-6864, 6909-6915, 6960-6969, 7011-7023, 7062-7073, 7113-7123
- OPD: NR 05-02, Harrison Bay North; Blocks: 7001-7007, 7051-7059, 7101-7112
- OPD: NR 05-03, Teshekpuk; Blocks: 6015-6024, 6067-6072
- OPD: NR 05-04, Harrison Bay; Blocks: 6001-6015, 6052-6066, 6106-6115, 6157-6168, 6208-6223, 6258-6274, 6309-6324, 6360-6374, 6410-6424, 6461-6471, 6513-6519, 6565-6566
- OPD: NR 06-03, Beechy Point; Blocks: 6202-6207, 6251-6257, 6301-6308, 6351-6361, 6401-6417, 6456-6469, 6509-6520, 6561-6570, 6612-6614, 6616, 6618-6623, 6664-6674, 6717-6724, 6768-6771, 6819-6822, 6870-6871
- OPD: NR 06-04, Flaxman Island; Blocks: 6651, 6701-6702, 6751-6754, 6802-6808, 6860, 6910-6912, 6920-6924, 6961-6974, 7013-7022, 7066-7070, 7118-7119

- OPD: NR 07-03, Barter Island; Blocks: 6853-6855, 6901-6909, 6958-6960, 7010-7011, 7061-7063, 7113-7114
- OPD: NR 0705, Demarcation Point; Blocks: 6016-6017, 6067-6069, 6118-6120, 6169-6170, 6222-6223, 6273-6275, 6324-6325

We evaluated geophysical/geological and archaeological data and determined that the area shoreward of the stamukhi zone and areas inside the barrier islands may have preserved, submerged prehistoric sites. The prehistoric archaeological site potential was analyzed with respect to the distribution and survivability of potential preserved terrestrial sediments and submerged landforms.

III.C.4.a(3) Review of the Baseline Study

No new baseline studies exist for archaeological resources in the Beaufort Sea. The EIS analysis for the Liberty Development and Production Plan is the most current and was referred to while we prepared this report.

III.C.4.a(4) Review of Reports on Geology and Cultural Resources

We reviewed the following geohazards and geotechnical reports to prepare this analysis:

- The Liberty Cultural Resources Report (Watson Company [1999]).
- The Liberty High Resolution Geophysical Survey, Foggy Island Bay in Stefansson Sound, Alaska (Watson Company [1998a]).
- Liberty Pipeline Route Survey, Foggy Island Bay in Stefansson Sound (Watson Company [1998b]).
- Geotechnical Exploration Liberty Development Project, Foggy Island Bay, Alaska (Duane Miller & Assocs. [1997]).
- Geotechnical Exploration Liberty Development North Slope, Alaska (Duane Miller & Assocs. [1998]).
- Beaufort Sea Shallow Hazards Synthesis Liberty #1 Well (Arctic Geoscience, Inc. [1997]).
- Geophysical and Geotechnical Site Evaluation, Karluk Prospect, Beaufort Sea Alaska (Harding Lawson Assocs. [1988]), in support of Chevron USA’s Karluk OCS-Y 0194 Well #1.
- Geotechnical Investigation Tract 42 Well Site, Beaufort Sea, Alaska, (Harding-Lawson Assocs. [1981b]), for Shell Oil Company’s Tern Prospect.
- Geologic Hazards Report for Shell Oil Company’s Tern Prospect (Harding-Lawson Assocs. [1981]).
- The Warthog No. 1 Camden Bay, Beaufort Sea, Shallow Hazards Survey Results (Fairweather E&P Services Inc. [1997a]). (This was reviewed because of its relevance to potential archaeological resources in the shallow Beaufort Sea).
- Archaeological Assessment Report for the Arco Warthog Prospect, Camden Bay, Beaufort Sea, Alaska 1997, MMS, in-house report.
- Pre-Historic Archaeological Assessment of Phillips Alaska Inc.’s McCovey Prospect, Beaufort Sea, Alaska, (Arctic Geoscience Inc. [2000]).
- Geohazards Survey, Phillips Alaska Inc.’s McCovey Prospect, Beaufort Sea, Alaska, (Arctic Geoscience Inc. 2000]).

III.C.4.a(5) Review of Sea-Level History

Any area within the Beaufort Sea shallower than 200 feet (60 meters) would have been exposed as dry land and available for people to live on until the sea level rose and flooded the project area sometime around 5,000-6,000 years Before Present. Relative sea level in the Beaufort Sea was approximately 165 feet (50 meters) below its present level at 13,000 years Before Present (Hopkins, 1967), which is just before the general timeframe for the arrival of people in the Arctic. Blocks in water deeper than the 165-foot (50-meter) isobath would not have archaeological resource potential and have been removed from further consideration in this report.

III.C.4.a(6) Review of Geological/Geophysical Data to Determine the Potential for Survival of Archaeological Sites

The geohazards and geotechnical reports and surveys collected in the areas of the Warthog #1, Liberty #1, and proposed McCovey exploration well and Liberty Project area suggest there may be the potential for archaeological resources to have survived the destructive erosional processes that operated on the coast as sea level rose and sculpted the seafloor. Sediment core(s) collected in Camden Bay and in Foggy Island Bay, Stefansson Sound contained peat layers in the upper Quaternary section. Peat does not prove the existence of archaeological resources but shows that there is the potential for the preservation of Quaternary-age sedimentary sequences, including possible archaeological sequences, in these nearshore areas. It also shows that erosion from ice gouging, thermokarst erosion, etc., was not significant enough to thoroughly rework the entire upper Quaternary section.

The subbottom profiler data show the presence of well-preserved Quaternary-age fluvial channels within these areas (Figure III.A-10a; see also USDOI, MMS, Alaska OCS Region, 2002a:Figure VI.C-10). The subbottom profiler data from the proposed Liberty pipeline route also show a buried lake or lagoon with underlying peat beds approximately 12 feet (3.5 meters) below the seafloor (USDOI, MMS, Alaska OCS Region, 2002a:Figure VI.C-11). The age of the peat is unknown. Adjacent to this buried depression is a seafloor shoal that may represent a drowned island. The buried edge of this island terminates in a possible buried paleo-terrace at the edge of the paleo-lagoon or paleo-lake. The banks, terraces, and point bars of these channels and lagoons, and areas on paleo-islands, are areas where, according to terrestrial site analogues, prehistoric people would have located their campsites and focused their subsistence activities. Because these channel features appear to be well preserved, any archaeological sites that are present also could be preserved. Also, because the channels and lagoon terraces are buried by only a few meters of Holocene sediments, any sites would be detectable with physical sampling techniques such as sediment coring.

In general we do not have any exact age correlation for sediment or buried and drowned landforms that can determine whether they are early to middle Pleistocene or whether they are younger late Pleistocene to Holocene. Age dating on organic sediments has been conducted on only two samples from nearshore Camden Bay. These samples, one on a piece of woody material and the other on a shell fragment, gave dates of nearly 20,000 years Before Present. However, these fragments may have been from older sediments that were redeposited in the Holocene sequence.

The analysis of prehistoric resources for previous Beaufort Sea sales concluded that destructive geologic processes such as ice gouging, thermokarst erosion, and storm surges had strongly reworked the near-surface shelf sediments in the Beaufort Sea Planning Area. Therefore, it was previously concluded that prehistoric archaeological sites had a very low potential for survival. The geophysical data from the nearshore areas, such as Warthog in Camden Bay and the Liberty Project area, contradict this previous conclusion. Information from the side-scan sonar and underwater video images of the seafloor show that ice gouging is sparse to nonexistent at these two locations. Evidence shows that locations beneath/near floating shorefast ice and landward of the barrier islands get more protection from ice gouging and other destructive geologic processes that operate on the open shelf and, perhaps, were sheltered from some of the erosional effects of rising sea level.

Thus, after reviewing geophysical high-resolution data and geotechnical core data from the Warthog, Liberty Project, and McCovey areas, we conclude that prehistoric archaeological sites may exist and may have survived the destructive geologic processes of the Holocene sea transgression and those that operate at the modern seafloor.

III.C.4.b. Historic Resources

Historic resources pertain “to the period of time for which written history exists” (MMS Manual 620.1-H) including, but not limited to, shipwrecks.

III.C.4.b(1) Onshore

A review of the Alaska Heritage Resources Survey site files shows sites with historic components in the Beaufort Sea Planning Area. They consist of a Distant Early Warning line station and its research equipment and habitation, cemetery, military debris, camp, hunting, reindeer herding, trapping, ice cellar, and lookout-tower site types (see Table III.C-20) (Dale, 1996, pers. commun.; Alaska Heritage Resources Survey Database, 2002).

III.C.4.b(2) Offshore

Our computerized list of shipwrecks for the sale area shows 20 known shipwrecks. They range from the whaler *St. George* lost in 1876 between Point Barrow and Point Tangent to Inupiaq whaling craft lost as recently as 1992. Along with the *St. George*, nine other Yankee whalers were lost in 1876. All nine vessels were caught in the ice and abandoned 20-30 miles north of Cape Simpson. Other vessels lost from Barrow and eastward, and potentially within the proposed lease-sale area, are the *Young Phoenix* lost in 1888 east of Barrow; the *Reindeer*, a 340-ton whaling bark wrecked near Reindeer Island in the Midway Islands in 1894; the *Duchess of Bedford*, a 60-ton expedition schooner wrecked near Flaxman Island in 1907; the *Elvira* lost east of Barter Island in 1913; the *Duxbury* lost near Cape Halkett in 1925; the *Baychimo* last seen off Barrow in 1931; and modern-day Inupiat whaling craft lost off Point Barrow in 1988, off Kaktovik in 1988, and two lost off Cross Island in 1992 (Burwell, 2002, pers. commun.; Tornfelt and Burwell, 1992; see Table III.C-21and Map 15, Archaeological Blocks and Location of Shipwrecks in the Multiple-Sale Area).

The final distribution of a shipwreck on the seafloor depends on such factors as water depth; the composition and thickness of unconsolidated sediments at the seafloor; ice gouging, sea currents, and other geologic processes active at the seafloor; and the size and type of ship. To date, no surveys have been done to find these wrecks, and the information we have is not enough to assign them to specific locations.

Rates of sedimentation sufficient to bury shipwrecks within recent history have not been identified for the sale area. Therefore, any shipwrecks present within the sale area should be locatable with sonar survey instruments.

III.C.5. Land Use Plans and Coastal Management Program

III.C.5.a. Land Status and Use

Most land in the North Slope Borough is held by a few major landowners. The predominant landowner within the Borough is the Federal Government. Of the approximately 20 million hectares in the region north of 68° N. latitude, more than one-half are contained in the National Petroleum Reserve-Alaska and the Arctic National Wildlife Refuge. Other major landholders include the State of Alaska (1.4 million hectares) and the eight Native village corporations and the Arctic Slope Regional Corporation (1.9 million hectares). Complexity in land-ownership patterns is a result of the Alaska Native Claims Settlement Act provisions that only surface-estate rights are to be conveyed to Native village corporations; subsurface-estate rights can be conveyed to Native regional corporations. Moreover, in selected Federal holdings, such as the Arctic National Wildlife Refuge and the National Petroleum Reserve-Alaska, selection was restricted to surface estate for village corporations. The subsurface estate was reserved for the Federal Government; the Arctic Slope Regional Corporation was required to select its subsurface estate outside these boundaries.

Major land uses on the North Slope are divided between traditional subsistence uses of the land and hydrocarbon-development operations. The traditional settlement patterns and subsistence uses of land are discussed in Section III.C.3. The extent and location of hydrocarbon exploration and development and production operations on the North Slope and offshore areas are discussed in the description of projects included for the cumulative case, Section V.A.

III.C.5.b. Land Use Planning Documents

Documents addressing land use in the North Slope Borough include the North Slope Borough Comprehensive Plan and Land Management Regulations, and the North Slope Borough Coastal Management Program (CMP). The North Slope Borough CMP and the Statewide Standards of the Alaska Coastal Management Program (ACMP) are described in the following section.

North Slope Borough Comprehensive Plan and Land Management Regulations: The North Slope Borough Comprehensive Plan and Land Management Regulations were adopted initially in December 1982, and they were revised on April 12, 1990. The following description is based on the new regulations. The revisions simplified the regulatory process but did not alter the basic premise of the comprehensive plan—to preserve and protect the land and water habitat essential to subsistence living and the Inupiat character of life.

The new Land Management Regulations have five zoning districts—Village, Barrow, Conservation, Resource Development, and Transportation Corridor. All areas within the Borough are in the Conservation District unless specifically designated as within the limited boundaries of the villages or Barrow, as a unitized oil field within the Resource Development District, or along the Trans-Alaska Pipeline corridor within the Transportation Corridor. Therefore, any new large-scale development occurring outside an existing Resource Development District will require a Master Plan for the development to be submitted to the North Slope Borough and adopted by the Borough Assembly as an amendment to the Comprehensive Plan, and the land must be rezoned from Conservation District to Resource Development District.

In the regulations, uses are categorized as (1) uses that can be administratively approved without public review, (2) uses that require a development permit and must have public review before they can be administratively approved, and (3) uses that are considered conditional development that must be approved by the Planning Commission.

Policy revisions in the Land Management Regulations incorporated the North Slope Borough CMP's and supplemented these with several additional policy categories—Village Policies, Economic Development Policies, Offshore Development Policies, and Transportation Corridor Policies. Offshore policies are specifically limited to development and uses in the portion of the Beaufort Sea that is within the boundary of the North Slope Borough. All the policies address offshore drilling.

III.C.5.c. Coastal Management

The Federal Coastal Zone Management Act and the Alaska Coastal Management Act were enacted in 1972 and 1977, respectively. Through these acts, development and land use in coastal areas are managed to provide a balance between the use of coastal areas and the protection of valuable coastal resources. The provisions and policies of both the Federal and State CMP's are described in MMS Reference Paper 83-1 (McCrea, 1983), which is summarized in the following paragraphs and incorporated by reference in this EIS. Statewide standards of the ACMP may be refined through local coastal programs prepared by coastal districts. Coastal districts are encouraged to prepare local CMP's to supplement the Statewide standards in their district. District programs must be approved by the Alaska Coastal Policy Council and the Secretary of the U.S. Department of Commerce through the Office of Ocean and Coastal Resource Management before they are fully incorporated into the ACMP. The NSB is the only coastal district in proximity to the sale area; its CMP has been fully incorporated into the ACMP. A description of the North Slope Borough CMP follows that of the Statewide standards of the ACMP.

III.C.5.c(1) Statewide Coastal Management Standards

The ACMP, as initially approved by the Office of Ocean and Coastal Resource Management, includes the Alaska Coastal Management Act, guidelines and standards developed by the Coastal Policy Council, a series of maps depicting the interim boundaries of the State coastal zone, and an EIS prepared by the Office of Ocean and Coastal Resource Management. The Statewide standards that may be relevant to activities hypothesized in this EIS are summarized in the following paragraphs under three headings: coastal habitats, coastal resources, and uses and activities.

III.C.5.c(1)(a) Coastal Habitats

Eight coastal habitats were identified in the standards (offshore; estuaries; wetlands and tidelands; rocky islands and sea cliffs; barrier islands and lagoons; exposed high-energy coasts; rivers, streams, and lakes; and important uplands). Each habitat has a policy specific to maintaining or enhancing the attributes that contribute to its capacity to support living resources (6 AAC 80.130[b] and [c]).

Activities and uses that do not conform to the standards may be permitted if there is a significant public need, no feasible prudent alternatives to meet that need, and all feasible and prudent mitigation measures are incorporated to maximize conformance. Habitat policies frequently are cited in State consistency review

III.C.5.c(1)(b) Coastal Resources

Two policy areas come under the heading of coastal resources: (1) air, land, and water quality and (2) historic, prehistoric, and archaeological resources. In the first instance, the ACMP defers to the mandates and expertise of the State of Alaska, Department of Environmental Conservation. The standards incorporate by reference all the statutes, regulations, and procedures of the Department of Environmental Conservation that pertain to protecting air, land, and water quality (6 AAC 80.140). Concerns for air and water quality are cited frequently during State reviews for consistency.

The policy addressing historic, prehistoric, and archaeological resources requires only identification of the "areas of the coast which are important to the study, understanding, or illustration of national, state, or local history or prehistory" (6 AAC 80.150).

III.C.5.c(1)(c) Uses and Activities

Nine topics are addressed under this heading: coastal development, geophysical-hazard areas, recreation, energy-facility siting, transportation and utilities, fish and seafood processing, timber harvesting and processing, mining and mineral processing, and subsistence. Uses and activities of particular relevance to the activities hypothesized for this OCS lease sale include coastal development, energy-facility siting, transportation and utilities, and subsistence.

Both the Federal Coastal Zone Management Act and the ACMP require that uses of State and Federal concern be addressed (Coastal Zone Management Act § 303[2][C], AS 46.40.060, and AS 46.40.070). The Alaska Coastal Management Act further stipulates that local districts may not arbitrarily or unreasonably restrict or exclude such uses in their CMP's. Among the uses of State concern is the siting of major energy facilities.

III.C.5.c(2) North Slope Borough District Coastal Management Plan

The North Slope Borough CMP was adopted by the Borough in 1984. Following several revisions, the Borough's CMP was approved by the Alaska Coastal Policy Council in April 1985 and Office of Ocean and Coastal Resource Management in May 1988. The coastal management boundary adopted for the North Slope Borough CMP varies slightly from the interim boundary of the ACMP. In the mid-Beaufort sector, the boundary was extended inland on several waterways to include anadromous-fish-spawning and -overwintering habitats. Along the Chukchi Sea coast, it was extended inland to include the Kukpuk River and a 1.6-kilometer corridor along each bank.

The North Slope Borough CMP was developed to balance exploration, development, and extraction of nonliving natural resources and maintenance of and access to the living resources on which the Inupiat traditional cultural values and way of life are based. The North Slope Borough CMP contains four categories of policies: (1) standards for development, (2) required features for applicable development, (3) best-efforts policies that include both allowable developments and required features, and (4) minimization-of-negative-impacts policies.

Standards for development prohibit severe harm to subsistence resources or activities or disturb cultural and historic sites. Required features address reasonable use of vehicles, vessels, and aircraft; engineering criteria for offshore structures; drilling plans; oil-spill-control and -cleanup plans; pipelines; causeways;

residential development associated with resource development; and air quality, water quality, and solid-waste disposal.

Best-efforts policies allow for exceptions if (1) there is "a significant public need for the proposed use and activity" and (2) developers have "rigorously explored and objectively evaluated all feasible and prudent alternatives" and briefly documented why the alternatives have been eliminated from consideration. If an exception to a best-efforts policy is granted, the developer must take "all feasible and prudent steps to avoid the adverse impacts the policy was intended to prevent."

Best-efforts policies allow development if all feasible and prudent steps are taken "to avoid the adverse impacts the policy was intended to prevent." Policies in this category address developments that could cause significantly decreased productivity of subsistence resources or ecosystems, displace beluga whales in Kasegaluk Lagoon, or restrict access of subsistence users to a subsistence resource. They also create restrictions on various modes of transportation, mining of beaches, or construction in certain floodplains and geologic-hazard areas.

Best-efforts policies also address features that are required by "applicable development except where the development has met the [two criteria identified above] and the developer has taken all feasible and prudent steps to maximize conformance with the policy." Developments and activities regulated under these policies include coastal mining, support facilities, gravel extraction in floodplains, new subdivisions, and transportation facilities. Siting policies include the State habitat policies and noninterference with important cultural sites or essential routes for transportation to subsistence resources.

All applicable developments must minimize "negative impacts." Regulated developments include recreational uses, transportation and utility facilities, and seismic exploration. Protected features include permafrost, subsistence activities, important habitat, migrating fish, and wildlife. Geologic hazards must be considered in site selection, design, and construction.

Two "areas meriting special attention" were identified in the CMP—Point Thomson and Kasegaluk Lagoon. Upon further examination, Point Thomson was dropped and the Colville River Delta was added. Planning for the Kasegaluk Lagoon area meriting special attention and the Colville River Delta area meriting special attention is proceeding.

The North Slope Borough has adopted administrative procedures for implementing these policies based on the permit process established under Title 19 of the Borough's Land Use Regulations and the consistency-review process of Title 46 of the Alaska Statutes.

III.C.6. Environmental Justice

Alaska Inupiat Natives, a recognized minority, are the predominant residents of the North Slope Borough, the area potentially most affected by the Beaufort Sea multiple sales. Effects on Inupiat Natives could occur because of their reliance on subsistence foods, and exploration and development may affect subsistence resources and harvest practices.

Environmental justice is an initiative that culminated with President Clinton's February 11, 1994, Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," and an accompanying Presidential memorandum. The Executive Order requires each Federal Agency to make the consideration of environmental justice part of its mission. Its intent is to promote fair treatment of people of all races, so no person or group of people shoulders a disproportionate share of the negative environmental effects from this country's domestic and foreign programs. It focuses on minority and low-income people, but the Environmental Protection Agency defines environmental justice as the "equal treatment of all individuals, groups or communities regardless of race, ethnicity, or economic status from environmental hazards" (U.S. Department of Energy, 1997; Envirosense, 1997). Specifically, the Executive Order requires an evaluation in the EIS as to whether the proposed project would have "disproportionately high adverse human health and environmental effects…on minority populations and low income populations."

Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments," requires MMS to be in consultation with Inupiat tribal governments on the North Slope on Federal matters that significantly or uniquely affect their communities. The Environmental Protection Agency's own Environmental Justice guidance of July 1999 stresses the importance of government-to-government consultation. In acknowledgement of its importance, the MMS has invited tribal governments to participate in the EIS planning process. In January 2001, MMS's community liaison Albert Barros was instrumental in getting a USDOI Alaska Regional Government-to-Government policy signed by all the USDOI Alaska Regional Directors. The MMS has come to appreciate the potential overload to stakeholder institutions that can occur from too many planning and public meetings. The Inupiat People of the North Slope have made the MMS aware of this potential meeting "burnout," and MMS has been sensitive to this in planning the number and timing of meetings with North Slope tribal groups and local governments.

Since 1999, all MMS public meetings have been conducted under the auspices of Environmental Justice, and presentations on the Executive Order and how MMS is addressing it have been made in Barrow, Nuiqsut, Kaktovik, and Point Hope. At these meetings, Inupiat translators were provided. The Environmental Justice process followed for the Beaufort Sea multiple sales included: (1) initial scoping, (2) notices in local newspaper notices and on local cable TV, and (3) followup meetings that included meetings specific to Environmental Justice concerns. Some meetings were broadcast over local radio. From this process, the MMS received limited interest and feedback on specific Environmental Justice concerns. Nevertheless, the MMS documented various concerns of Inupiat residents, and discussions about mitigation were conducted. Environmental Justice concerns were taken back to MMS management and incorporated into environmental study designs and new mitigating measures. New mitigating measures/stipulations being evaluated include one for no siting of permanent facilities in the vicinity of Cross Island and one for noise abatement in areas near bowhead whale subsistence-hunting areas.

Environmental Justice concerns were solicited from meetings on the North Slope with the communities of Nuiqsut on October 16, 2001, with Barrow on October 18, 2001, and with Kaktovik on October 19, 2001. A Slopewide Government-to-Government teleconference arranged through the Inupiat Community of the Arctic Slope was held on December 6, 2001, and involved the tribal governments of Point Hope, Point Lay, Wainwright, Atqasuk, Nuiqsut, and Anaktuvuk Pass. Kaktovik chose not to participate in the teleconference, and a separate meeting with the Native Village of Barrow had already been held in Barrow on October 18, 2001. MMS maintains a dialogue on Environmental Justice with these communities; follow-up meetings to address Environmental Justice issues were held with the Inupiat Community of the Arctic Slope and the Alaska Eskimo Whaling Commission on November 15, 2001.

Major concerns expressed at these meetings included:

- the need for continued participation by the North Slope Borough in the multiple-sale planning process;
- the multiple-sale process will diminish local input into the planning process;
- the need for a 10-mile deferral around Cross Island;
- support for a Barter Island deferral;
- more concrete guidelines for the consultation process;
- agencies need to help fund the Kuukpik Subsistence Advisory Panel;
- take local traditional knowledge seriously in decisionmaking;
- the need for oil-spill response training in the villages;
- the need for impact assistance;
- better employment opportunities from oil industry;
- the need for conflict resolution agreements with subsistence seal hunters and fishermen;
- the need for establishing a Slopewide subsistence advisory panel;
- the need to provide natural gas to local communities;
- the need for better assessment of cumulative impacts;
- continued fears about ice gouging damaging undersea pipelines;
- ice damage to gravel drilling islands;
- oil-spill cleanup in broken ice;
- problems with netting fish in the Colville River;

- noise effects on bowhead whales; and
- air pollution from development at Prudhoe Bay.

The Executive Summary for the draft EIS was translated into the Inupiat Language and distributed to the Native Village of Nuiqsut, Native Village of Kaktovik, Native Village of Barrow, Inupiat Community of the Arctic Slope, Alaska Eskimo Whaling Commission, Inupiat Heritage Center, Ilisagvik College, North Slope Borough, City of Nuiqsut, and the City of Kaktovik. MMS plans to translate the Executive Summary of the Final EIS and distribute it to the same entities.

SECTION IV

ENVIRONMENTAL CONSEQUENCES

Contents Section IV

IV. Environmental Consequences

Section IV analyzes effects on resources in or migrating through the proposed lease-sale area. Based on a three-tier process, Section IV.A defines basic assumptions made in assessing the alternatives in this EIS (excluding Alternative II). Section IV.B discusses Alternative II (No Lease Sale). Section IV.C analyzes effects on the 16 different resource categories in three areas by alternative and by sale. Sections IV.D through IV.I are general topics common to all resources.

IV.A. Basic Assumptions for Effects Assessment

Certain basic assumptions are common to the effects assessments for all the alternatives, except Alternative II - No Lease Sale. A general overview of the Proposal (offering the entire sale area) shows that certain properties are common for the entire sale area, no matter where the action takes place or which alternative is chosen. The alternatives are analyzed on the basis of a field-development time profile called a scenario. The MMS traditionally bases the EIS scenarios on both geologic possibilities and on what is expected to be leased, discovered, developed, and produced in the sale area under consideration. This subsection details the scientific, economic, geologic, and other assumptions on which the exploration and development scenarios in this EIS are based. These topics include discussions of basic scenarios for exploration, development, production, and transportation. The location of any oil deposits is purely hypothetical, until oil is proven to be there by drilling (see Appendix B). While these scenarios are reasonable and provide a basis for analyzing the effects, considerable uncertainty exists about where and when activities may take place, if they take place at all. In addition to uncertainty about the size and location of geologic resources, many other factors would influence where leasing, exploration, and development might take place. Such factors as the price of oil, the availability of high-grade onshore oil and gas leases, and company goals and perspectives about Alaska and offshore development would have tremendous effects on the level of participation in offshore oil and gas exploration and development in the Beaufort Sea.

While reading the effects assessment, please note that the MMS has developed scenarios to aid in the development of a complete and comprehensive analysis of the various possibilities that might arise from leasing, exploration, and development. The alternatives in this EIS evaluate leasing from Barrow to the Canadian border and from shore to about 60 miles offshore. The scenarios developed by the MMS indicate a logical progression from the nearshore central Beaufort Sea to locations in deeper water or farther east or west. The three zones (Near, Midrange, and Far) mentioned are developed and defined in Section II.A.1 (also see Map 4). The scenarios developed by the MMS indicate our analytical assumption, based on professional judgment, that most leasing, exploration, and development that might result from Sales 186 and 195 would take place in the Near and Midrange zones offshore of current development. Although the scenarios prepared for this EIS do not assume development in the Far Zone until after Sale 202, companies could bid on and be awarded leases in any of the zones in any of the three sales. Because this EIS evaluates the effects of leasing in all three zones, the effects attributed to any zone could occur as a result of any lease sale, if they occur at all.

The remainder of this section evaluates the potential effects of the Proposal and all the alternatives. The information in this section is presented by resource and evaluates the effects common to all alternatives, followed by an analysis for each alternative. In addition to the Proposal (Alternative I) and the No Lease Sale Alternative (Alternative II), four other alternatives for the three proposed lease sales (Sales 186, 195, and 202) create 18 potential options. In many cases, the estimated effects of a specific alternative for a particular sale are identical or similar to those effects of the alternative for another sale and/or another alternative for another sale. In such cases, rather than repeat the analysis, we reference the effect already described for another alternative and sale combination that would have the same effect. This narrative will include the appropriate rationale and information developed supporting the grouping.

To help focus, we provide only the information that will help the reader and decisionmaker focus on the differences among the alternatives. Table Summary compares the effects by alternative and sale.

Each analysis of effects in this EIS evaluates the following key resource topics that were identified during scoping:

- Water Quality
- Lower Trophic-Level Organisms
- Fishes
- Essential Fish Habitat
- Endangered and Threatened Species: Bowhead Whale and Spectacled and Steller's Eiders
- Marine and Coastal Birds
- Marine Mammals: Pinnipeds, Polar Bear, and Beluga and Gray Whales
- Terrestrial Mammals: Caribou, Muskoxen, Grizzly Bear, and Arctic Fox
- Vegetation and Wetlands
- Economy of the North Slope Borough
- Subsistence-Harvest Patterns
- Sociocultural Systems
- Archaeological Resources
- Land Use Plans and Coastal Management Programs
- Air Quality
- Environmental Justice

If leasing takes place, we can project that impacts likely would occur from the following:

- noise from seismic surveys, aircraft, and marine support boats and
- traffic from seismic-survey vessels and aircraft.

If exploration does take place, the following impacts, in addition to the aforementioned seismic activities, could result:

- noise from construction or installation of ice roads, exploration drilling island, or platform;
- traffic for crew, fuel, and supply vessels;
- discharge of well-drilling fluids, produced water, and domestic wastewater generated from the exploration facility;
- solid-waste disposal from exploration wells (drilling muds and cuttings) and trash and debris from the human activities supporting exploration;
- gaseous emissions from offshore and onshore facilities and transportation vessels and aircraft; and
- physical emplacement, presence, and removal of exploration facilities.

If exploration leads to development, impacts likely could occur from the following:

- noise from construction of ice roads, development of production islands or facilities, pipelines, and production facilities;
- routine and recurring traffic associated with crew and supply activities;
- liquid-waste disposal from well-drilling fluids, produced waters, and domestic wastewaters generated at the offshore facility;
- solid-waste disposal from development wells (muds and cuttings) and trash and debris from production activities;

- gaseous emissions from production facilities, both onshore and offshore, and from transportation vessels and aircraft; and
- physical placement, presence, and removal of offshore production facilities, including islands or platforms, storage and production facilities, and pipelines to onshore common carrier pipelines.

Other accidental activities could, but are not expected to, occur. Oil-spill accidents (blowouts, production accidents, pipeline leaks, and fuel spills) also could occur. The reader and decisionmaker(s) should consider the low probability that an oil spill might occur when considering the spill and cleanup effects. Even though the analysis assumes that an oil spill occurs and provides information about the potential that an oil spill would contact a specific area or resource, the reader should remember that the estimate of an oil spill greater than or equal to 1,000 barrels occurring from any of the three proposed lease sales and contacting any resource is 8-10%. Also, when reading our estimate of the effects of an oil spill, the reader should note that the EIS does not assume any reduction in effects that would result from required oil-spill-response activities. All exploration and production activities require an approved oil-spill-response plan and, if an oil spill occurred, oil-containment and -cleanup activities would begin within hours or minutes of the detection of a spill.

Sections IV.D through IV.I are common to all alternatives for Sales 186, 195, and 202, and are analyzed by resource category. These include the following topics:

- Comparison of the Effects of the Alternatives and the Cumulative Effects
- Unavoidable Adverse Effects;
- Relationship Between Local-Short-Term Uses and Maintenance and Enhancement of Long-Term Productivity;
- Irreversible and Irretrievable Commitment of Resources;
- Effects on Natural Gas Development and Production;
- Effects of a Low-Probability, High Effects, Very Large Oil-Spill Event.

IV.A.1. Significance Thresholds

The Council on Environmental Quality National Environmental Policy Act (NEPA) regulations (40 CFR 1508.27) define the term “significantly” in terms of both context and intensity. “Context” considers the setting of the Proposed Action, what the affected resource might be, and whether the effect on this resource would be local or more regional in extent. “Intensity” considers the severity of the impact, taking into account such factors as whether the impact is beneficial or adverse; the uniqueness of the resource (for example, threatened or endangered species); the cumulative aspects of the impact; and whether Federal, State, or local laws may be violated. The analysis in this document uses terminology that is consistent with that definition. Impacts may be beneficial or adverse. Impacts are described in terms of frequency, duration, general scope, and/or size and intensity. The analysis in this EIS also considers whether the mitigation that is proposed as part of the project can reduce or eliminate all or part of the potential adverse effects.

As directed by the Council on Environmental Quality NEPA regulations (40 CFR 1502.16), we discuss direct and indirect impacts (effects) and their significance on the previously listed physical, biological, and human social resources.

Our EIS impact analyses address the significance of the impacts on the aforementioned resources considering such factors as the nature of the impact (for example, habitat disturbance or mortality), the spatial extent (local and regional), temporal and recovery times (years, generations), and the effects of mitigation (for example, implementation of the oil-spill-response plan). Bowhead whales, for example, are an endangered species, and the analysis considers the possible effects of a large oil spill in terms of the following:

- lethal and nonlethal effects;
- habitat affected;
- seasonality and spatial extent of the effect;
- what part of the population may be affected;

- oil-spill-cleanup mitigation;
- the likelihood of such a spill; and
- if such a spill occurred, the likelihood of the oil contacting whales.

For impacts on water quality from construction disturbance, the analysis considers the following:

- the increases in suspended particles and turbidity relative to acute (toxic) criteria;
- the seasonal, temporal, and spatial extent of the effect; and
- the contribution of this relative to naturally occurring turbidity.

Some impacts may be measurable, but their effects may be minimal and/or short-term in duration; therefore, they may not require avoidance or mitigation.

Adverse impacts that are reduced by mitigation below the "significance thresholds" that are incorporated into the project, or that are demonstrated to be acceptable because the risk of the impact occurring is small, are considered "nonsignificant."

For this EIS, we have defined a "significance threshold" for each resource as the level of effect that equals or exceeds the adverse changes indicated in the following impact situations:

- **Threatened and Endangered Species** (bowhead whale, spectacled and Steller's eiders): An adverse impact that results in a decline in abundance and/or change in distribution requiring one or more generation for the indicated population to recover to its former status.

- **Biological Resources** (seals, walrus, beluga whale, polar bear, marine and coastal birds, terrestrial mammals, lower trophic-level organisms, fishes, essential fish habitat, and vegetation and wetlands): An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status and one or more generations for polar bears.

- **Subsistence-Harvest Patterns:** One or more important subsistence resources would become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1-2 years.

- **Sociocultural Systems:** Chronic disruption of sociocultural systems occurs for a period of 2-5 years, with a tendency toward the displacement of existing social patterns.

- **Archaeological Resources:** An interaction between an archaeological site and an effect-producing factor occurs and results in the loss of unique, archaeological information.

- **Economy:** Economic effects that would cause important and sweeping changes in the economic well-being of the residents or the area or region. Local employment is increased by 20% or more for at least 5 years.

- **Water Quality:** A regulated contaminant is discharged into the water column, and the resulting concentration outside a specified mixing zone is above the acute (toxic) State standard or Environmental Protection Agency criterion more than once in a 1-year period and averages more than the chronic State Standard or Environmental Protection Agency criterion for a month. Turbidity exceeds 7,500 parts per million suspended-solid concentration outside the mixing zone specified for regulated discharges more than once in a 3-year period and averages more than chronic State standards or Environmental Protection Agency criteria for a month. The accidental discharge of crude or refined oil in which the total aqueous hydrocarbons in the water column exceeds 1,500 micrograms per liter (1.5 parts per million), the assumed acute (toxic) criteria, for more than 1 day and 15 micrograms per liter (0.015 parts per million), the assumed chronic criteria and the State of Alaska ambient-water-quality standard, for more than 5 days.

- Violations would be caused by exceeding an effluent limit or creating an oil sheen. The accidental discharge of a small volume of crude or refined oil also might cause an adverse impact and could result in concentrations of hydrocarbons that are greater than the acute criteria in a local area (less than 1 square mile) for less than a day and concentrations that are greater than the chronic criteria in a larger area (less than 100 square miles) for fewer than 5 days. However, an action of violation or accidental discharge of a small volume crude or refined oil would not necessarily constitute a significant environmental impact as defined in 40 CFR 1508.27.

- **Air Quality:** Emissions cause an increase in pollutants over an area of at least a few tens of square kilometers that exceeds half the increase permitted under the Prevention of Significant Deterioration criteria or the National Ambient Air Quality Standards for nitrogen dioxide, sulfur dioxide, or particulate matter less than 10 microns in diameter; or exceeds half the increase permitted under the National Ambient Air Quality Standards for carbon monoxide or ozone.
- **Environmental Justice**: The significance threshold for Environmental Justice would be disproportionate, high adverse human health or environmental effects on minority or low-income populations. This threshold would be reached if one or more important subsistence resource becomes unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1-2 years; or chronic disruption of sociocultural systems occurs for a period of 2-5 years, with a tendency toward the displacement of existing social patterns. Tainting of subsistence foods from oil spills and contamination of subsistence foods from pollutants would contribute to potential adverse human health effects.

IV.A.2. Exploration, Development and Production, Timing of Activities, Transportation Assumptions, and Abandonment

IV.A.2.a. Assumed Resources

All hydrocarbon resources estimated to be produced as a result of proposed Lease Sales 186, 195, and 202 should be crude oil. The production of gas is not considered feasible at this time, because there is no gas-transportation system from the North Slope to outside markets (see Section IV.H). Available oil-resource estimates for the entire program area range between 1.68 billion barrels and 2.87 billion barrels when correlated to market prices of $18 and $30 per barrel (in 2000$). We assume that higher prices would be required to develop the more remote and/or difficult oil reservoirs. Resource estimates assumed to be discovered and developed for each of the proposed sales vary between 340 and 570 million barrels of oil, assuming market prices ranging between $18 and $30 per barrel (in 2000$). For purposes of analysis, the MMS has assumed that each sale would have the potential to produce 460 million barrels of oil over the lifetime of its field production.

An expanded discussion of the resource estimates of the proposed action is found in Sections II.A and II.B and Appendix B. Tables IV.A-1 through IV.A-4 show the levels of infrastructure and resources estimated for the proposed action. These assumptions may overestimate effects, because the MMS has held seven sales on the Beaufort Sea OCS and, to date, the only production is the relatively small amount from the Federal portion of the Northstar facility, which started producing October 31, 2001.

IV.A.2.b. Timing of Activities

The level of exploration- and development-related activities and the timing of events for the proposed action are shown on Tables IV.A-1 through IV.A-4 and in Appendix B. For purposes of analysis, we have created the following scenarios.

Sale 186 would be held in 2003. Exploratory drilling would begin in 2004 and continue until 2009, with delineation wells drilled through 2010. No more than two drilling rigs would operate at any time, with a total of six exploration and six delineation wells expected to be drilled over the 7-year exploration period. A maximum of two exploration platforms would be in service during any year, assuming one exploration rig per platform. If the first commercial discovery is made in 2005, 2 years after the sale date, production from Sale186 would begin by 2010. Between 2009 and 2014, three production platforms are expected to be installed. Two platforms would be in the Near Zone, and one would be in the Far Zone. Drilling production and injection wells would begin in 2009 and conclude in 2017, with a total of 102 wells drilled. Offshore pipeline construction would begin in 2009 and finish in 2015, with 40 miles of new offshore pipeline installed. The offshore pipeline would connect to existing onshore pipelines and, therefore, construction of new onshore pipelines would be minimal. Oil production from Sale 186 would end by 2033.

Sale 195 would be held in 2005. Exploratory drilling would begin in 2007 and continue until 2013, with delineation wells drilled through 2014. A maximum of two drilling rigs would operate at any time, with a total of six exploration and six delineation wells expected to be drilled over the 8-year exploration period. The first commercial discovery is assumed to be made in 2008, 3 years after the sale date, and production from Sale195 would begin by 2013. Between 2012 and 2017, two production platforms are assumed to be installed. One platform would be in the Near Zone, and one would be in the Midrange Zone. Drilling of production and injection wells would begin in 2012 and finish in 2019, with a total of 102 wells drilled. Offshore pipeline construction would begin in 2012 and finish in 2016, with 40 miles of new offshore pipeline installed. The offshore pipeline would connect to existing onshore pipelines and, therefore, construction of new onshore pipelines would be minimal. Oil production from Sale 195 would end by 2036.

Sale 202 would be held in 2007. Exploratory drilling would begin in 2010 and continue until 2018. Only one drilling rig would operate at any time, with a total of six exploration and five delineation wells assumed to be drilled over the 9-year exploration period. Only one exploration platform in the Far Zone with a single drill rig would be in service during any year. If a commercial discovery is made in 2012, 5 years after the sale date, production from Sale 202 would begin by 2019. Between 2018 and 2019, two production platforms are assumed to be installed. Drilling production and injection wells would begin in 2018 and finish in 2022, with a total of 102 wells drilled. Offshore pipeline construction would begin and finish in 2018, with 35 miles of new offshore pipeline installed. Oil production from Sale 202 would end by 2038.

Many of these estimates are based on a 45-day open-water season, which historically has been highly variable. Ice conditions, regulatory effects, and general weather patterns can either lengthen or shorten the estimated open-water season. In the Beaufort Sea, this season generally ranges from mid-August to early October.

IV.A.2.b(1) Activities Associated With Exploration Drilling

As noted, exploration activities could begin in 2004 and continue through 2018. Because of the short open-water drilling season in the Beaufort Sea, it is likely that a single drilling rig would drill a single well at any drilling site in any one year. However, in the event of a discovery, two delineation wells could be drilled by the same exploration rig in the same season. The type of units that might be used in exploration drilling would depend on water depth, sea-ice conditions, ice-resistance of the units, and availability of drilling units. Artificial ice islands grounded on the seabed and supported by ice roads constructed on landfast ice would be used in shallower water depths of 15-30 feet (5-10 meters). It is less likely that gravel islands would be constructed for exploratory drilling. Older artificial islands or natural shoals could be used as a base for temporary gravel or ice islands. Some leases could be drilled from existing gravel islands using extended-reach drilling. However, should the lease operators consider that a gravel island is necessary, it likely would be constructed in water depths less than 40 feet (12 meters); it could be built from barges in summer but likely would be built in winter. Gravel used to construct the island would be hauled over ice roads from onshore sources. About 60% of gravel is estimated to be needed for a production island in similar water depths. Personnel and material would be carried to and from the various shallow-water platforms over ice roads (in winter) and by boats and barges (in summer). In water 33-66 feet (10-20 meters) deep, movable platforms resting on the seafloor likely would be used for exploration. These platforms are designed to withstand winter ice forces, and drilling could be conducted year-round. In water deeper than 66 feet (20 meters), drillships or other types of floating platforms would be used. These floating systems can operate only in open-water and broken-ice conditions and not in midwinter pack-ice conditions. They would be supported by icebreakers and supply boats during the summer months and stored in protected inshore areas when not in use.

Based on geologic studies, the MMS assumes that exploration and delineation wells generally would test prospects from 3,000-15,000 feet (914-4,572 meters), and we assume a representative exploration-well depth of 7,000 feet (2,133 meters). At this depth, each exploratory or delineation well would require 425 short tons of drilling muds (dry weight) and produce approximately 525 short tons of dry rock cuttings. We assume that 80% of the drilling muds would be recycled, leaving 85 tons of "spent mud" to be discharged along with all the drill cuttings at the exploration site or disposed of onshore. We estimate 935-1,040 short tons (dry weight) of drilling muds and 5,775-6,300 short tons (dry weight) of bore cuttings would need to be disposed for the exploration and delineation activities for each sale. The lower figure is estimated for Sale 202 and higher number for Sales 186 and 195. These materials would be disposed of primarily at the drill site under conditions prescribed by the Environmental Protection Agency's National Pollution Discharge Elimination System (Clean Water Act of 1977, as amended [33 U.S.C. 1251 et seq.).

On completion of the exploration-drilling program the operator, depending on the type of platform used, may do the following: allow the ice island to melt, remove the protective berm from the gravel island and allow it to disperse from wave action, or mine the gravel island for other construction projects. Should economically recoverable oil resources be discovered, the gravel island could be enhanced for production activities. At the end of the exploration phase, a deepwater steel and/or concrete exploration platform would be either floated out and used in another field or be reinforced and used as a production platform should that be required.

IV.A.2.b(1)(a) Seismic-Survey Activity

Before exploration and production activities, the MMS requires the lessee/operator to conduct surveys to define any shallow hazards or archaeological resources that may be present. If geological/geophysical evidence shows that specific lease blocks might have the potential for archaeological resources, either prehistoric or historic, a site clearance is required. These surveys usually incorporate seismic profiling. The projected level of seismic activity varies by the number of wells that may be drilled. Site-specific surveys of the exploration- and delineation-well sites would be conducted during the ice-free seasons of the years of the exploratory phase. We estimate each survey would cover roughly six OCS blocks (9 square miles or 23 square kilometers) for each exploration well. For Sales 186, 195, and 202, the total area covered by these surveys would equal 54 square miles (approximately 138 square kilometers). The average time needed to survey each site should range between 2 and 5 days, allowing for down time for bad weather and equipment failure. Other factors affecting seismic surveys are climate, oceanography, and geology.

IV.A.2.b(1)(b) Support and Logistic Activities

Offshore exploration-drilling operations in the Beaufort Sea multiple-sale area would require onshore support facilities. Where possible, existing facilities within the Prudhoe Bay or Kuparuk unit areas would be used or upgraded. These onshore facilities would have to provide the following:

- a staging area for construction equipment, drilling equipment, and supplies;
- a transfer point for drilling and construction personnel;
- a harbor to serve as a base for vessels required to support offshore operations; and
- an airfield for fixed-wing aircraft and helicopters.

Existing systems would be used to transport equipment, material, supplies, and personnel. The descriptions of North Slope transportation systems as contained in Section III.C of the Northeast National Petroleum Reserve-Alaska final EIS (USDOI, Bureau of Land Management and MMS, 1998) and Sections 3.2 and 3.3 of the Beaufort Sea Oil and Gas Development/Northstar Project, final EIS, (U.S. Army Corps of Engineers, 1999) are incorporated by reference and updated where appropriate.

Existing surface-transportation routes, including both pipelines and roads, traverse about a quarter of the North Slope. They extend from the Endicott field facilities located on the Beaufort Sea coast to just west of the Kuparuk field. Gravel roads, which parallel existing pipelines, connect existing oil-production facilities between the Kuparuk and Endicott fields. One gravel road, east of the Colville River, connects the main Alpine pad with its airstrip. Most exploration activities are supported by ice roads that must be reconstructed each year. The Prudhoe-Kuparuk region is linked to interior Alaska by the Dalton Highway. The majority of the vehicles traveling the Dalton Highway are commercial freight vehicles associated with oil-field activities, although privately owned vehicles and commercial-tour operators also travel the Dalton Highway. Summer-traffic levels for the Dalton (June-August) are substantially higher than traffic levels for the rest of the year.

Air transportation is the primary means of passenger travel to the North Slope Borough and Prudhoe Bay/Kuparuk area. All public airstrips, except those at Barrow and Deadhorse, are gravel. The North Slope Borough continually upgrades local roads and airports. A private airfield capable of handling jet aircraft also is located at the Kuparuk Unit base camp.

Barges transport most heavy and bulky cargo to the North Slope Borough. Prudhoe Bay has barge-docking facilities at both the East Dock and the West Dock; however, the West Dock facility is larger and more active. Crowley Maritime operates several heavy-lift cranes, barges, and barge docks in addition to support vessels from the West Dock. Oliktok Dock was constructed in 1982 to expedite shipping to the Kuparuk Field. Barge traffic in support of continued development on the North Slope of Alaska typically has, over time, ranged from 10-15 barges per year. During the initial development of the Prudhoe Bay Unit in 1970, 48 barges were used; however, newer barges are larger and more efficient and would sharply reduce that number. Barges supporting exploration activities would travel directly to the drill site to offload any cargo. Typically, a mobile drilling platform used for exploration drilling would enter its area of operation fully supplied for the drilling season.

The number of required support vessels for each bottom-founded drilling unit would depend, at least in part, on the type and characteristics of the unit and the sea-ice conditions. If drilling operations occur during the open-water season, the MMS requires an emergency-standby vessel within the immediate vicinity (5 miles or a 20-minute steaming distance, whichever is less) of the drilling unit to ensure emergency evacuation of personnel. This vessel also could assist in deploying the oil boom in the event of an oil spill. If operations are planned during broken-ice conditions, two or more icebreaking vessels may be required to perform ice-management tasks for the floating units. One to two potential drilling units might be operating during the open-water period.

During the open-water season (again, assuming a 45-day season), a supply boat would make one trip per rig per week. We estimate the total number of supply boat trips per open-water season could be as high as 14 for Sales 186 and 195 and 7 for Sale 202. The level of support-boat traffic would vary by distance from shore and/or support base and whether the facility can be supported by vehicles using ice roads in the winter.

The estimated numbers of vessel, helicopter, or vehicle trips are calculated as round trips. Estimates of vehicle trips do not include operations that may be necessary for rig demobilization or for emergencies.

Ice roads are assumed to be the principal route for transporting routine supplies and materials to ice islands and/or nearshore gravel islands. For drilling platforms farther offshore in the broken-ice zone, material and supplies would be transported by support/supply boats (with icebreaking capacity, if necessary) during the open-water season and by helicopter at all other times. For both types of drilling structures, it is probable that most personnel would be transported by helicopters. The number of helicopter trips flown in support of exploration- and delineation-well drilling is assumed to range from about 90-270 each year, depending on the number of wells (1-3) that are drilled. For each drilling operation, we assume there would be one flight per day of drilling. The time required to drill and test a well is about 90 days. For Sales 186, 195, and 202, the annual number of helicopter trips to the drill sites should average between 140 and 155.

If exploratory drilling occurs in water close to existing infrastructure and within driving distance of an existing airstrip, operators may choose to transport crews by ice road when reasonable, especially during periods of inclement weather.

IV.A.2.b(2) Activities Associated with Development and Production

Assumptions associated with development and production strategies are highly speculative. This scenario is characteristic of the type of development that could accompany production. Work on offshore and onshore production and transportation facilities would not begin until the engineering and economic assessments of the potential reservoirs was completed and the conditions of all the permits were evaluated. As noted in Section IV.A.2.b, delineation wells are assumed in 2006 for Sale 186, 2009 for Sale 195, and 2013 for Sale 202. Production is assumed to begin in 2010, 2013, and 2019, respectively. Production for

Sale 186 would peak in 2019 and end in 2033; for Sale 195, it would peak in 2018 and end in 2036; and for Sale 202, production would peak at 38.6 million barrels annually between 2020 and 2024 and end in 2038.

IV.A.2.b(2)(a) Seismic-Survey Activity

A three-dimensional, multichannel, prospect-defining, seismic-reflection survey would be conducted for each of the production platforms. The survey would cover approximately 35 square miles (92 square kilometers) for each production platform. The platform sites might be surveyed several years before the installation of the platform; surveys would be conducted during open-water, ice-free periods. High-resolution seismic-reflection data for shallow hazards would be collected before laying the offshore pipeline. The total trackline distance, estimated to be four times the length of the offshore trunk pipelines assumed for each sales scenario, would equal approximately 160 miles each for Sales 186 and 195 and 140 miles for Sale 202. Seismic activities and assumptions for development are similar to those described for exploration activities (see Section IV.A.2.b(1)(a)).

IV.A.2.b(2)(b) Production Platforms and Production Drilling

Assumed hydrocarbon production and development information is given in Tables IV.A-1, IV.A-2, and IV.A-3, should commercial discoveries result from the above exploration activities. For Sales 186 and 195, we assume 69 production wells and 33 injection wells would be drilled from three production platforms. For Sale 202, 68 production wells and 34 injection wells would be drilled from two platforms. Drilling of each production and service well would require 650 short tons (dry weight) of drilling mud per well and 825 tons of rock cuttings. We assume that 80% of the mud is recycled and 130 tons per well be disposed of in the subsurface by service/injection wells on the production platform. The disposal of muds and cuttings and any produced water would be in accordance with approved National Pollution Discharge Elimination System permits for development-well drilling. The amount of disposed drilling muds would be about 13,300 tons for all wells drilled for each sale. The total amount of disposed cuttings for each sale would amount to 84,000 short tons (dry weight). These calculations are based on a production well with a representative depth of 10,000 feet (3,050 meters).

Depending on the water depth, seafloor conditions, ice conditions, and size of the reservoir, several types of platforms could be used. In water depths less than or equal to 30 feet (10 meters), artificial (gravel) and or caisson-retained islands may be used as production platforms. For water depths between 30 and 100 feet (10 and 30 meters), bottom-founded structures designed with ice-management systems are likely. Icebreaking support ships may be required onsite. For waters deeper than 100 feet (30 meters), a combination of extended-reach wells and/or subsea well tied back to the main production platform in shallower water is most likely.

A variety of steel and concrete structures of various designs can be built and used for a production platform that resists seawater, ice, and freeze-thaw cycles and operates safely in low-temperature, offshore environments such as the Beaufort Sea. Bottom-founded production platforms would be constructed and outfitted in ice-free harbors and moved to the production site. Modular units would be transported during the open-water season and assembled and installed in less than 45 days. In addition to the vessels (8-10 tugboats) used to tow the platform components to the site, installation also might require a large-capacity derrick barge and a vessel to accommodate the workers. Each platform could use two rigs to maximize development drilling and shorten startup times.

Gravel needs and transportation requirements for island construction would vary according to water depths. The BPXA proposal for the Liberty Project, estimated 800,000 cubic yards of gravel would be needed to construct a production Island in 22 feet (7 meters) of water (USDOI, MMS, Alaska OCS Region, 2002a). For Northstar Island, an estimated 700,000-800,000 cubic yards of gravel was hauled to the site of a relic exploration island. At the former exploration island site, about 400-500,000 cubic yards of gravel remained. Consequently, Northstar Island, which lies in 39 feet of water (12 meters), required approximately 1.2 million cubic yards of gravel. For both islands, construction material was carried on ice roads, with needed additional gravel excavated from onshore sites (U.S. Army Corps of Engineers, 1999).

At the end of production and the abandonment of the production platform, the following might occur. The gravel island's protective concrete or sandbag berm would be removed and allowed to disperse from wave action. The island's gravel resources may be removed and used for other construction projects. A far-offshore steel-production platform could be floated out and scrapped, or the structure could be sunk and allowed to become an artificial reef. This last option has proved effective in enhancing fish and benthic habitat offshore in the Gulf of Mexico. In all cases, the pipelines would be flushed and any remaining oil removed.

IV.A.2.b(2)(c) Support and Logistics Activities

For this scenario, it is assumed that the infrastructure at Prudhoe Bay would provide the major support for construction and operation activities associated with the development, production, and transportation of crude oil. However, as the development of the proposed sale area progresses into tracts farther from Prudhoe Bay and/or into deeper waters, new shore-base locations may be required. One new shore base is assumed for the development of Sale 202 resources (see Table IV.A-3) and is assumed to be located at Point Thomson in the west or Smith Bay in the east. It could be located anywhere in the eastern or western Beaufort Sea.

Support and logistics operations after discovery can be divided broadly into three phases: construction, development drilling, and production. Transportation needs for each project are initially and briefly intense and then decline over time. For the now-deferred Liberty Project, forecast construction-phase transport requirements for helicopter round trips ranged from 10-20 flights per day during the construction phase to 3-7 trips per week during the operation/production phase. Marine-support trips to the Northstar structures during the construction phase were estimated at 125-150 trips during the open-water season. This figure also includes sealift barges. Marine transport estimates declined to 4-6 trips per season during the operations/production phase. For surface transport during the construction phase, estimates for Northstar and Liberty were roughly 36,000 round trips (400 per day), assuming a 90-day season. Surface transport estimates are expected to decline to 100-200 per season during the operations/production phase.

As construction/development operations move farther from existing infrastructure and into deeper water, beyond the landfast-ice zone, the burden of transport would shift increasingly to helicopter and, more importantly, marine transport. Personnel, perishable goods, and emergency material would be transported by helicopter during all but the open-water season. During the construction phase, dredges would prepare the seafloor for bottom-founded structures; any fill or gravel required would be barged to site from shore or dredged from offshore sites. The open-water season would be the focus of activity as barges from outside the sale area and local support vessels fulfill the platforms' yearly construction and operating requirements. Icebreaking vessels would be on standby to extend the open-water season and to support ships in case of emergency activities.

Marine transport requirements during construction for far/deepwater facilities most likely would range between 150 and 250 vessel trips during the open-water season. This number would include barges carrying construction supplies from outside ports, dredges, survey vessels, pipelaying barges, and local support vessels. Should subsea completions be used to produce deepwater finds, gathering lines would transport production to platforms that could be located in shallower waters. In this event, air and marine transport requirements would be reduced. During the period of developmental drilling (8 years for Sale 186, 7 years for Sale 195, and 5 years for Sale 202), helicopter trips for far/deepwater platforms would range from 7-14 per week per platform. During the production phase, average weekly helicopter operations could range between 3 and 7 trips per platform.

Table IV.A-4 summarizes the exploration, development, production, and transportation assumptions for all Alternatives for each of the three sales. Transportation information presented in this table is based on the assumption that all three production platforms constructed as a result of Sale 186 would be in the shallow-water landfast-ice zone; that one of the three production platforms assumed for Sale 195 would be in the shallow-water zone and the other two would be in the Midrange or Far Zone; and that both production platforms for Sale 202 would be beyond the landfast-ice zone and located in the Midrange or Far Zone.

IV.A.2.b(3) Activities Associated with Oil Transportation

IV.A.2.b(3)(a) Pipelines

For Sales 186 and 195, installation of offshore pipelines between production platforms and onshore facilities would take 1-2 years. Trenching and pipeline laying would take place during the relatively short open-water season or during mid- to late winter, when the landfast ice has stabilized. New onshore-pipeline sections would take 1-2 years to complete, with construction activities taking place simultaneously with the offshore-pipeline installation. For Sale 202, installation of offshore pipelines between production platforms and onshore facilities would take 2-4 years, considering that route surveys, trenching, and pipeline laying would take place in the relatively short open-water season. New onshore pipeline sections would take 2-4 years to complete, with construction activities taking place simultaneously with the offshore pipeline installation. We assume that for all sales, offshore pipelines would be trenched as a protective measure against damage by ice in all water depths less than 165 feet (50 meters). At coastal landfalls, pipelines would be elevated on short gravel causeways to protect them against shoreline-erosion. Booster stations at the landfalls would be required to maintain pressure in the long pipeline segments. Onshore, pipelines would be elevated on vertical support members. The onshore pipeline and shore facility would be constructed simultaneously with the installation of the offshore platforms.

For economic and logistical reasons, future offshore developments would attempt to use the existing onshore infrastructure (processing facilities and pipeline networks) whenever possible. This would be especially true for Sale 186, given the sale's assumed small field sizes. Produced oil would be gathered by existing pipeline systems within the Prudhoe Bay/Kuparuk field areas and transported to Pump Station 1 of the Trans-Alaska Pipeline System. Landfalls are assumed at Oliktok Point (using the Kuparuk field infrastructure), Northstar pipeline landfall, West Dock area (using the Prudhoe Bay infrastructure), and the Badami field. For Sale 195, we assume that new offshore projects would tie into existing onshore pipeline-gathering systems at the nearest possible points. Produced oil would be gathered by existing pipeline systems to Pump Station 1 of the Trans-Alaska Pipeline. We assume that landfalls would be Oliktok Point, Northstar pipeline, West Dock, and Bullen Point (a new facility to support development in the Point Thompson unit). Because Sale 202 may feature projects that are developed in remote locations, new onshore pipelines would be required to reach the existing North Slope gathering system connecting to Pump Station No. 1 of the Trans-Alaska Pipeline. Depending on the location of the field, a new landfall would be constructed in Smith Bay (discovery in the western Beaufort) and traverse south of Teshekpuk Lake through the National Petroleum Reserve-Alaska to the Kuparuk field infrastructure, a distance of approximately 50 miles (80 kilometers). Existing field infrastructure in the central Beaufort (Oliktok, Northstar, Endicott, Badami) could be used for oil production from deepwater areas offshore from the central Beaufort coastline. If the new field is found in the eastern Beaufort, a new landfall and facility expansion in the Point Thomson area would be constructed. The pipeline would pass along the coast and join the Badami pipeline, a distance of approximately 12 miles (19 kilometers). As only one new, remote field is expected, there would be only one landfall and one new processing facility.

IV.B.2.b(3)(b) Tankers

Crude oil produced from Sales 186, 195, and 202 leases would be transported by pipeline to the oil terminal at Valdez, where it would be commingled with crude produced from other North Slope sources. Once at Valdez, the oil would be loaded into tankers for transport primarily to the U.S. West Coast, with smaller quantities traveling to the Kenai Peninsula, Hawaii, the Gulf of Mexico, the Far East, or refineries in the Virgin Islands. Tankers loaded with oil produced from Sale 186 are expected to depart Valdez during 2010. Sale 195 tanker departure should begin sometime in 2013, and Sale 202 departures should begin at some point during 2019. Valdez tanker-transport traffic generated by the Proposal is approximated in Table IV.A-4. Assuming the use of 100,000 deadweight-ton tankers, we estimate that at the peak of production, Sales 186, 195, and 202 would generate 63 tanker loadings and departures in 2016, 56 in 2018, and 55 in 2020-2024, respectively.

IV.A.3. Disturbance Effects

Activities such as oil and gas exploration, development, and production could disturb the ecosystems in which they are taking place. Unlike oil spills, which are probabilistic in nature and unlikely to occur, disturbances are likely to occur if there are any postsale activities. In general, disturbance effects would result from industrial activities, noise, and habitat alteration.

IV.A.3.a. Disturbance Caused by Industrial Activities

If a lease sale occurs and exploration and/or development occur, the industrial activities associated with oil and gas exploration and development would generate disturbances to the environment. These disturbances would occur from both exploration and, if an economic field is discovered, development and production activities. Exploration disturbances include seismic activities (Section IV.A.2.b(1)(a)) and support and logistic activities (Section IV.A.2.b(1)(b)). If exploration is successful, disturbances would occur from seismic activity (Section IV.A.2.b(2)(a)), production platform and production drilling activities (Section IV.A.2.b(2)(b)), support and logistic activity (Section IV.A.2.b(2)(c)), and oil-transportation operations, in both construction and operation phases (Section IV.A.2.b(3)).

Some of the disturbances, such as exploration and construction of production and transportation facilities would occur primarily during the winter and would be completed in one or two winter seasons. Once construction is completed, disturbances from the operation of the production facilities would occur over a 15-20 year period and would occur year-round. The analyses in Section IV.C describe and evaluate the effects of disturbances first.

Some of the aforementioned disturbances generate noise (seismic and drilling activities), habitat alterations (construction of islands and pipelines), and discharges to both the air and water.

IV.A.3.b. Disturbance Caused By Noise

Noise generated by industrial activities can come from a variety of sources, such as transportation, general machinery use, construction, gravel mining, pile drivers, seismic surveys, and human activity. Noise, whether carried through the air or under water, may cause some species to alter their feeding routines, movement, and reproductive cycles. Most specifically, concerns about noise have been raised regarding marine and terrestrial mammals, marine birds, and related subsistence activities. See Section IV.C for a discussion of the effects of noise on resources in the multiple-sale area.

IV.A.3.c. Disturbance Caused By Habitat Alteration

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 construction, new types of infrastructure, alteration of stream flow, influx of different cultural groups, an increase in available jobs, oil spills, etc. All of the resources discussed in this EIS would be affected through habitat alteration. An alteration to the habitat of the bowhead whale, marine mammals, and birds could significantly alter the cultural resources and quality of life of the Inupiat people. See Section IV.C for a discussion of habitat alteration on resources in the multiple-sale area.

IV.A.3.d. Discharges to the Marine Environment

Should there be a discovery and development of oil resources for Sales 186, 195, and/or 202, the related construction of infrastructure locally would disturb the water quality of some of the affected area. Constructing gravel islands, building on- and offshore ice roads, trenching for pipelines, and other activities would create and require mining of onshore (and possible offshore) gravel deposits. Increased sedimentation, the removal of gravel, the use of freshwater to create onshore ice roads, and changes in stream flow due to gravel removal or new road and pad locations could have effects on some benthic and fish populations. See Section IV.C.1 for a discussion of discharges to water quality and possible disturbance to the rivers and lakes.

IV.A.3.e. Discharges to the Air

Effects on air quality would come from industrial emissions related to vessel traffic, construction machinery, compressors, generators, and various types of engines. Other effects on air quality would come from evaporation of spilled oil into the atmosphere or in situ burning of hydrocarbons, in the unlikely event of an oil spill. See Section IV.C.15 for a discussion of disturbance to air quality.

IV.A.4. Oil Spills

A major concern we heard during scoping was the potential effects of oil spills. The EIS oil-spill analysis considers three spill-size categories: (1) large spills, those greater than or equal to 1,000 barrels; (2) small spills, those less than 1,000 barrels; and (3) very large spills, those greater than or equal to 150,000 barrels. The oil-spill-trajectory model addresses the movement of spills greater than or equal to 1,000 barrels. The oil-spill-trajectory model results are appropriate only for "large" spills greater than or equal to 1,000 barrels. Small spills are analyzed without the use of the oil-spill-trajectory model.

IV.A.4.a. Large Oil Spills

We define large oil spills as greater than or equal to 1,000 barrels. This introduction summarizes the assumptions we use to analyze large oil spills for each alternative. The section locations for the analysis of small and very large spills are shown under IV.A.4.c - Locations of Oil-Spill Analyses.

The assumptions about large oil spills are a mixture of project-specific information, modeling results, statistical analysis, and professional judgment. For details on any of these points, please read Appendix A. We believe this is the basis for understanding the discussions about the effects of large oil spills on resources of concern in Section IV.C.

We estimate that a large spill is unlikely to occur based on a mean spill number ranging from 0.08-0.11 for Alternative I for Sales 186, 195 and 202 and their alternatives. For purposes of analysis, we assume one large spill occurs anywhere from Alternative I for Sales 186, 195, and 202 or their alternatives. This "what if" analysis of oil spills addresses whether such spills could cause serious environmental impact.

The analysis of a large spill represents the range of effects that might occur from a range of likely offshore or onshore spill sizes from the Alternative I for Sales 186, 195, and 202 or their alternatives. Table IV.A-5 shows the large spill sizes we assume for purposes of analysis range from 1,500-4,600 barrels for crude and diesel oil. The spills are broken out as follows:

Crude oil

- production facility (includes storage tanks), 1,500 barrels
- offshore pipeline, 4,600 barrels

For further information on how we derive the information in Table IV.A-5, please read Appendix A.

In terms of timing, a large spill from the Alternative I for Sales 186, 195, and 202 or their alternatives could happen at any time during the year. We assume that the production facility would not retain any oil. 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

The analysis of a large spill examines the weathering of the assumed spills. We assume the oil will be similar to Alaska North Slope crude oil. The spill sizes are 1,500 and 4,600 barrels. We simulate two general scenarios, one in which the oil spills into open water and one in which the oil freezes into the ice and melts out into 50% ice cover. We assume open water is July through September, and a winter spill melts out in July. For open water, we model the weathering of the 1,500- and 4,200-barrel spills as if they are 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, the MMS 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 oil without cleanup. Tables IV.A-6a and IV.A-6b summarize the results we assume for the fate and behavior of Alaska North Slope crude oil and diesel oil in our analysis of the effects of oil on environmental and social resources. After 30 days in open water or broken ice:

- 27-29% evaporates,
- 4-32% disperses, and
- 28-65% remains.

After 30 days under landfast ice:

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

We base the analysis of effects from large oil spills on the following assumptions:

- One large spill occurs.
- The spill size is one of the sizes we show in Table IV.A-5.
- All the oil reaches the environment; the production facility absorbs no oil.
- The spill starts at the production facility or along the offshore pipeline.
- There is no cleanup or containment.
- The spill could occur at any time of the year.
- The spill weathering is as we show in Tables IV.A-6a and b.
- A spill under the landfast ice from the production facility or its pipeline does not move significantly until the ice breaks up (Appendix A).
- The spill area varies over time as we show in Tables IV.A-6a and b and is calculated from Ford (1985).
- The time and chance of contact from an oil spill are calculated from an oil-spill-trajectory model (Appendix A, Tables A.2-1 through A.2-54).
- The chance of contact is analyzed from the location where it is highest when determining effects.
- The overall chance of an oil spill occurring and contacting is calculated from an oil-spill-risk analysis model (Appendix A. Tables A.2-55 through A.2-72).

IV.A.4.a(1) The Chance of a Large Spill Occurring

After we analyze the effects of a large oil spill, we consider the chance of a large oil spill occurring. Even though the chance of one or more spills occurring and entering offshore waters is low (8-10%), we analyze the consequences of an oil spill because it is a significant concern to all stakeholders. The MMS uses the term “low” to characterize the relative chance of a large spill occurring, and it is based on our familiarity with oil-spill rates and sizes. We recognize that multiple stakeholders have different interests and different analytical perspectives that shape the way they think about spill occurrence and identify a preferred policy response. For some stakeholders, a 10% chance of a large spill over the life of the field may be high. For purposes of analysis, we use the term “low” to mean on the order of 8-10% over the life of the Alternative I for Sales 186, 195 and 202 or their alternatives.

IV.A.4.a(2) The Chance of a Large Spill Occurring and Contacting Resources of Concern

We also estimate the chance of one or more large spills occurring and contacting resources of concern over the lifetime of the project. After 30 days, the chance of one or more large spills occurring and contacting environmental resource areas, land segments, or boundary segments ranges from less than 0.5-2%.

IV.A.4.b. Small Spills

Small spills, though accidental, generally are routine and expected. We estimate small spills are likely to occur based on a mean spill number ranging from 299-387 for Alternative I for Sales 186, 195, and 202 and their alternatives. Most small spills occur into containment and do not reach the environment. The analysis of onshore Alaska North Slope crude oil spills is performed collectively for all facilities, pipelines, and flowlines. For purposes of analysis, this EIS assumes an average crude oil-spill size of 3 barrels (State of Alaska, Dept. of Environmental Conservation, 2001). Following is the estimated number and volume of small crude oil spills:

Alternative	Estimated Number of Spills	Estimated Total Spill Volume (barrels)
I	82	246
II	0	0
III	81	243
IV	78	234
V	80	240
VI	79	237

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

The typical refined products spilled are aviation fuel, diesel fuel, engine lube, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil (State of Alaska, Dept. of Environmental Conservation, 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 less than 1% by frequency and volume. For purposes of analysis, this EIS assumes an average refined-spill size of 0.7 barrels. Following is the estimated number and volume of refined spills:

Alternative	Estimated Number of Spills	Estimated Total Spill Volume (barrels)
I	202	141
II	0	0
III	201	141
IV	192	134
V	197	138
VI	197	138

IV.A.4.c. Locations of Oil-Spill Analyses

Following are section locations for the analysis of oil spills and their effects throughout this document:

- Section IV.B - Alternative II, No Lease Sale assumes no spill occurs, because no action occurs.
- Sections IV.C - Analysis of the effects of large and small oil spills from the Alternative I for Sales 186, 195, and 202 and their alternatives.
- Section IV.I - Analysis of the effects of very low probability, very large oil spills.
- Appendix A - supporting documentation for the assumptions we use in the oil-spill analysis in this EIS.

For more information on the analysis of oil spills, see Appendix A of this EIS and Johnson et al. (2002*) Oil Spill Risk Analysis: Beaufort Multisale.*

IV.A.5. Spill Prevention and Response

Each permittee operating offshore in the Beaufort Sea is required to have an Oil-Spill-Response Plan with trained personnel and cleanup equipment and supplies at each activity site to meet Federal and State regulations. An activity site would be the exploration site, drilling site, or production site, each with its ancillary facilities. Federal regulations governing these operations for the MMS are found in 30 CFR 250.300 and 254, respectively. These regulations deal with the prevention and control of oil spills and releases. Regulations 40 CFR 110, 112, and 300 deal with responses to spills or releases of oil and gas. Spill-response requirements would be thoroughly addressed when and if parcels are leased. For example, an Application for Permit to Drill would be evaluated for spill response regarding blowout-prevention equipment required and for the size of the containment and recovery equipment in relation to the potential blowout volume. These conditions are all very site specific. State regulations that may apply are covered in 18 AAC 75 and are administered by the Alaska Department of Environmental Conservation.

Leak detection of chronic small leaks over an extended period of time from buried subsea pipelines under the ice has been a concern. One of the requirements placed on the approval of the Northstar pipeline was the requirement to develop a prototype leak-detection system to be used in addition to the two proposed state-of-the-art systems. BPXA met this requirement by installing a German leak detection system, Leck Erkennurgs Ortungs Sytems (LEOS), which was developed 20 years ago for a pipeline project in Bavaria, Germany (*Oil and Gas Journal*, 2002). As stated in the article, the LEOS system detects a leak by collecting vapor through a liquid impermeable acetate layer within a perforated tube. The system is tested every 24 hours, and the sensitivity of the system depends on the type of the hydrocarbon being detected, proximity to the leak and, to a lesser extent, on the type of soil surrounding the sensor tube. The LEOS system was installed as part of the bundled-pipeline systems for the Northstar Project. Prior to transporting oil through the pipeline, the LEOS system was checked to ensure it was functioning properly (*Oil and Gas Journal*, 2002). As noted in the article, “After a year of operation the LEOS systems has been field calibrated to account for increasing background methane due to soil warming” (*Oil and Gas Journal*, 2002). The ability to detect hydrogen from all the anodes demonstrates the system is working. The article notes the leak-detection thresholds for fluids is less than 1 liter per hour and less than 1 cubic meter per hour for gas. This type of technology will help prevent large undetected oil spills from small chronic leaks under the ice.

The response plan includes response action plans, identifies worst-case spill volumes, provides a list of contacts for State and Federal agencies that require notification in the event of a spill, identifies oil-spill-response organizations that provide response support in the event of a spill, other private companies that can be called on for further information or assistance, and inventories of spill-response equipment. The environmental obligations of operators on a Federal offshore lease are described in MMS regulations contained in 30 CFR 254, *Oil Spill Response Requirements for Facilities Located Seaward of the Coast Line*.

By congressional action, the MMS is delegated the authority to ensure that wells drilled on Federal offshore lands are done so in a controlled manner. The MMS has the authority to cite the operator and bring civil and/or criminal charges to bear for failure to comply with Federal regulations. If there is a spill or release of petroleum fluids or chemicals used in the petroleum industry on the lease, unit, or participating area, the MMS has the authority to cite the operator. Cleanup of the site will occur under the direction of the Federal and State On-Scene Coordinators. The Federal On-Scene Coordinator is the U.S. Coast Guard for coastal zone spills, the U.S. Environmental Protection Agency for land-based spills. The State of Alaska, Department of Environmental Conservation is the State On-Scene Coordinator for spills impacting State lands and waters.

The MMS requires that oil spills greater than 1 barrel be reported to their authorized officer within 24 hours of the event. The MMS monitors the work of the lessee or operator to ensure that all personnel and equipment cited in the spill plan are available for response efforts and spills are appropriately cleaned up in accordance with all applicable laws and regulations.

In Alaska, the *Unified Plan for Preparedness to Oil Discharges and Hazardous Substance Release* developed by the Environmental Protection Agency and U.S. Coast Guard with the Alaska Department of Environmental Conservation identifies the governmental response network within the State of Alaska. The

Unified Plan is further augmented with regional subarea contingency plans that are specific to the areas of operation, such as the North Slope. The plans identify response resources located within the area and identify environmentally sensitive areas in the geographic region. The Department of the Interior is a member of the Alaska Regional Response Team and has adopted the Unified Plan. The intent of the applicable laws and regulations is to prevent, as much as possible, hazardous materials and oil from entering the water and to ensure the rapid removal of these substances from areas where there is a danger of contaminating water. The Federal and State On-Scene Coordinators monitor and document the operator's actions and determine when the cleanup is satisfactory, in coordination with the surface-land managers. On average, spill-response efforts result in recovery of approximately 10-20% of the oil released to the ocean environment.

Where a spill occurs determines how much of the spill will be recovered. For the 3-barrel crude oil spills that contact land or solid ice, the cleanup rate can be nearly 100%. Free product can be removed with skimmers and sorbent materials, and any contaminated soil or ice can be excavated and removed from the environment for disposal. For the same small spills contacting open water, recovery rates drop to about 10-20%. To effectively remove a spilled product from the ocean surface, the responder must be able to use boomers or ice to concentrate enough of the spilled material to allow for recovery. Small spills are difficult to concentrate in sufficient quantity for efficient skimmer collection

Again, effective recovery of small refined-product spills (0.7 barrel) depends on where the spill occurs. Spills occurring on land or solid ice will be cleaned up almost completely. The spills can be wiped or skimmed up and contaminated soil or ice excavated and disposed of properly. These same spills occurring in an open-water environment most likely would not be cleaned up. Because of their small size, it would be extremely difficult to collect a sufficient concentration of the spill to permit recovery by skimmers or sorbent materials.

IV.A.6. Constraints and Technology

IV.A.6.a. Spill Response, Containment, and Collection Equipment

Offshore operators in the Beaufort Sea currently maintain spill response, containment, and collection equipment to respond to releases the entire year. During winter solid-ice conditions, land-based spill-response tactics and equipment are used. The North Slope operators maintain sufficient equipment such as bulldozers, dump trucks, front-end loaders, snow blowers, trenching equipment, ditch witches, pumps, and skimmers to mount a response on top of the ice and under it (see Alaska Clean Seas tactics R-1 -R-31 [Alaska Clean Seas, 1998]). During the transitional periods of spring broken ice, fall freezeup, and open water, water-based response tactics and equipment are used as conditions allow. North Slope operators, through Alaska Clean Seas, maintain an ice-strengthened barge, an oil-storage barge, Point Class tugs to maneuver the barges, and numerous smaller response boats to mount a response effort in the varying ocean conditions.

In 2000, Alaska Clean Seas conducted a series of trials of the R-19A barge-based response tactic in spring broken ice-conditions and again in fall during freezeup conditions. The R-19A tactic involves using a response barge as a collection platform with smaller skimming systems deployed on either side of the barge during broken-ice conditions. These trials were key in establishing realistic operating conditions for all the components of the R-19A tactic, to include the barge, tugs, containment boom, skimmers, towboats, mini-barges and other workboats required to collect oil from the ocean surface. These demonstrations set an effective level of about 30% ice coverage of the ocean surface before the skimming system became ineffective because of ice intrusion into the boom.

During fall freezeup conditions, once ice crystals were present in the water, the R-19A skimming system was effectively shut down. The containment boom served to concentrate the ice crystals into a large mass that surrounded the skimming devices and choked them off from any oil that would be present in a spill. To get any flow of "oil" into the skimmer, the operator had to drastically increase the amount of water taken into the skimmer. Recovering more water relative to oil increases the amount of on-water storage and the number of decants that must be conducted to pump the water out of the storage barges once it has separated from the oil.

It should be noted that these trials were of one tactic. During the trials it was noted that the small-vessel skimming systems were more efficient in maneuvering in and around ice with fewer effects on the system. The North Slope operators are revising their response tactics to capitalize on this observation and incorporating tactics used by spill responders in Cook Inlet. In the Cook Inlet, spill responders also contest with broken ice mixed with swift currents and drastic tides. Cook Inlet responders effectively use free-skimming techniques with both barges and small vessels to access oil on or among the icefloes. Free skimming is conducted without a containment boom, and the response team relies on the ice to contain and concentrate oil to a sufficient thickness for recovery.

IV.A.6.b. In Situ Burning

Other response tactics not tested during the 2000 trials include in situ burning of oil and allowing oil to freeze in place for removal once ice conditions can support heavy equipment. In situ burning involves burning oil on whatever surface it is on–ice, water, or soil. The burning can remove in excess of 90% of oil from the aquatic environment. The residual material is then collected from the ocean surface and returned to the shore for appropriate disposal. Preapproval for in situ burning has been granted for the marine environment by the MMS. The Federal On-Scene Coordinator will make the decision, in coordination with the State On-Scene Coordinator, on whether to initiate an in situ burn. Burning can be conducted only when wind conditions are such that the smoke plume is carried away from villages or encampments.

To conduct an in situ burn, the oil must be collected and concentrated to a sufficient thickness to permit ignition and sustain burning. For in situ burning to be the most successful, burning operations need to be initiated as soon as possible, usually within the first 2-3 days of the spill. Once the crude oil begins to weather and lose the light volatile fractions, it becomes more difficult to ignite. Also, as the oil sits on the ocean surface, more water is incorporated into the oil forming an emulsion and further reducing the ability to initiate and sustain a burn. Emulsions containing more than 70% water generally will not burn. The application of emulsion breakers can reduce water content of the oil/water emulsion and increase the amount of oil that can be removed by burning.

Oil that has collected under the ice surface from a pipeline leak also is an excellent candidate for in situ burning. The ice and cold water prevent the oil from weathering. As the oil begins to surface as the ice breaks up, it essentially is fresh crude and can be ignited the same as oil released during open-water conditions.

IV.A.6.c. Allowing Oil to Freeze in Place

For spills occurring late in the season, a more appropriate response tactic may be to allow the oil to be frozen into place and freezing tracking buoys in with the oil so it can be located at a later date. Once ice conditions are stable enough to support land-based removal equipment, the response effort would begin. The contaminated ice and oil would be mined from the pack ice and taken back to shore for disposal. Once spring returns, the contaminated area would be monitored for any oil surfacing through brine channels in the ice sheet. When oil surfaces in the melt pools, Alaska Clean Seas would return and conduct in situ burning operations or skim the oil from the surface to complete removal of the oil from the environment.

IV.A.6.d. Further Research in Spill Response

The North Slope operators also have been actively engaged in research to improve spill-response equipment and tactics in the arctic environment. Along with the MMS, they have participated in the development of a prototypical skimmer for use in ice-infested water, the MORICE project. The MMS has sponsored considerable research in areas such as detection and tracking of oil in and under ice, behavior of oil in ice, in situ burning and fire boom research and development, use of ice booms, viscous oil pumping, and optimum timing for decanting storage barges to maximize on-water storage.

IV.A.6.e. Leak-Detection Systems

The Liberty final EIS (USDOI, MMS, Alaska OCS Region, 2002a:Section II.A.I.b(3)(b)) discusses various leak-detection systems. The primary system used on Alaska's North Slope is the pressure-point analysis and mass-balance line-pack compensation system. This system is considered as part of the best available and safest technology. The LEOS system, an external pipeline leak-detection system that identifies hydrocarbons in the water column through a permeable membrane, has been incorporated into the pipeline design for Northstar and is being used in operations at the Northstar site (see Section IV.A.5). The LEOS leak-detection system also is incorporated into the pipeline design for the Liberty Project.

Solid- and broken-ice conditions also serve to limit the ability to detect releases from subsea pipelines for the majority of the year. During solid-ice conditions, the operator has no visual means to determine if a release has occurred and must rely solely on the pipeline leak-detection systems. While these systems have detection levels of a few barrels, leaks could develop below the detection level and continue to discharge until breakup occurs and the oil begins to surface. Broken ice also can make it difficult to determine if a leak has occurred by obscuring the oil from sight.

One method to determine whether a leak has occurred during solid-ice conditions is to drill holes through the ice surface at various intervals throughout the solid-ice season. The MMS and others continue research to develop new technology to detect leaks in both solid-ice and broken-ice environments. Methods to date include satellite imagery, forward-looking infrared radar, acoustic-detection systems, and external pipeline leak-detection systems that identify hydrocarbons in the water column through a permeable membrane.

IV.A.6.f. Extended-Reach Drilling

A discussion of extended-reach drilling experience and technology is found in the Liberty final EIS (USDOI, MMS, Alaska OCS Region, 2002a:Appendix D-3). Although an extended-reach drilling well with a 6.67-mile horizontal departure has been drilled at the Wytch Farm field in Great Britain, it is unreasonable to assume that an exclusive extended-reach drilling development project (let alone an exploration well) could achieve the same success rate and cost-benefit ratio as a conventional drilling program for North Slope projects. This is based in part on (1) the lack of an adequate drilling history for the project, which can be obtained only through drilling experience and (2) the lack of comparable extended-reach drilling experience on the North Slope. When planning extended-reach drilling wells, a combination of several factors needs to be considered. These include rig capacity and capability, well design, geological conditions, and production capabilities. The extended-reach drilling records have been set in mature development areas and are based on an accumulation of drilling experience and geologic knowledge. Extended-reach drilling has not been used, or proposed, for a new startup exploratory drilling program or development project.

IV.A.6.g. Platform Types Related to Water Depth

A discussion of platform types in relation to water depth is discussed in the Northstar final EIS (U.S. Army Corps of Engineers, 1999:Volume II, Chapter III.4.2). Oil and gas exploration and development/production options are discussed for the breadth of the Beaufort Sea; options are based on available technology, both of the drilling platform to withstand environmental conditions and of the relationship of the surface expression of the platform in relation to the downhole drilling location. Water depth plays a prominent part in the selection of the platform type, as platform performance limitations and economic considerations are determining factors in choosing a compatible platform type. Tables 3-4 and 3-5 in the Northstar EIS (U.S. Army Corps of Engineers, 1999) include various technical options to consider in choosing platform types. Figure 3-6 provides a flow chart and decision tree in dealing with location and structure type.

IV.B. ALTERNATIVE II - No Lease Sale

We evaluate the effects of the No Lease Sale Alternative here rather than by resource-by-resource in Section IV.C. In this way, readers can consider and evaluate the potential impacts and environmental protection offered by this alternative, as they read the effects analysis for the other deferral alternatives.

There are tradeoffs to environmental protection and the selection of Alternative II - No Lease Sale.

Under this alternative, the leasing actions proposed in the Beaufort Sea multiple-sale EIS would not be approved. Should this occur, there would be no leases offered in the Beaufort Sea through 2007, and no oil and gas would be developed from any of the blocks considered for leasing in this EIS. None of the potential 1.38 billion barrels of oil would be produced (460 million from each sale), and there would be no potential oil spills and no effects to the flora and fauna either on- or offshore the Beaufort Sea coast. There would be no noise, habitat disturbance and alteration, or water discharges and air emissions from the activities associated with potential island and pipeline construction and operation from exploration drilling and development/production operations from these proposed lease sales. The economic benefits, royalties, and taxes to the Federal and State governments would be forgone.

To replace the potential 1.38 billion barrels of oil not developed from this Beaufort Sea multiple-sale program, a large portion of the oil would be imported from other countries. The associated environmental impacts from producing oil and transporting it to market still would occur. These imports have attendant environmental effects and negative effects on the Nation’s balance of trade.

IV.B.1. The Most Important Substitutes for Lost Production

The energy that would have flowed into the United States’ economy from this development would need to be provided from a substitute source. Possible sources include:

- other domestic oil production
- imported oil production
- other alternative energy sources such as
- imported methanol
- ethanol
- gasohol
- compressed natural gas
- electricity
- conservation in the areas of transportation, heating, or reduced consumption of plastics
- fuel switching
- reduction in the consumption of energy

If the proposed multiple-sale initiative is denied, substitute energy likely would be a mix of the above sources largely from imported oil production followed by conservation, additional domestic production, and fuel switching.

A new paper from the recent 5-Year OCS Oil and Gas Program entitled *Energy Alternatives and the Environment* (USDOI, MMS, 2001a), which is incorporated here by reference, discusses a long list of potential alternatives to oil and natural gas and evaluates their potential to replace a critical part of our county’s energy sources. The costs and reliability of these alternative sources make them less viable than oil and gas resources. It seems very likely that during the life of this project, oil and gas resources at or above the current levels will be used in the United States and the world to fuel our economies.

This paper also indicates that imports and additional domestic production will replace most of the lost oil production, while conservation and fuel switching will decrease the demand for fuel. Every fuel alternative, however, imposes its own negative environmental effects. The following list shows the approximate percent and quantity we expect would substitute for the lost oil (1.38 billion barrels). The quantity of conservation and fuel switching are in barrels of oil equivalent.

- Additional imports: 88% of the loss of production equivalent to 1.214 billion barrels.
- Conservation: 5% of the loss in production equivalent to 69 million barrels.
- Additional domestic production: 4% of the loss in production equivalent to 55 million barrels.
- Fuel switching: 3% of the loss in production equivalent to 41 million barrels.

IV.B.2. Environmental Impacts from the Most Important Substitutes

IV.B.2.a. Additional Oil Imports

Energy Alternatives and the Environment (USDOI, MMS, 2001a) indicates that if imports are increased to satisfy the demand for oil, the effects to the environment would be similar in kind to those of the Proposal but would happen in a different location. The species of animals and plants affected may be different, depending on the location of the development. Some of these effects still could occur within the United States from accidental or intentional discharges of oil, whether from tanker or pipeline spills. These events would:

- generate greenhouse gases and air pollutants from transportation and dockside activities;
- degrade air quality from emissions of nitrogen oxides and volatile organic compounds;
- degrade water quality; and
- destroy flora, fauna, and water.

The impacts of oil spills from additional imported oil are not likely to occur on the shores of the Arctic Ocean or, for the most part, in Alaska. Imported oil imposes negative environmental impacts in producing countries and in countries along trade routes. By not producing our own domestic oil and gas resources and relying on imported oil we are exporting, from a global perspective, at least a sizeable portion of the environmental impacts to those countries from which the United States imports and through or by which our imported oil is transported.

IV.B.2.b. Conservation

Substituting energy-saving technology (adding insulation to buildings or more efficient engines in vehicles, etc.) or consuming less energy (lowering thermostat settings during the winter; using public transportation rather than private automobiles) will conserve energy. The former could result in positive net gains to the environment but may require additional manufacturing. The amount of gain would depend on the extent of negative impacts from such manufacturing. Consuming less energy generally would have a positive environmental effect.

IV.B.2.c. Additional Domestic Production

Onshore oil production has notable negative impacts on surface water, groundwater, and wildlife. It also can cause negative impacts on soils, air quality, and vegetation and cause or increase noise and odors.

Offshore oil production may result in impacts similar to those of the Proposal, but they would occur in a different location. To the extent other offshore production offsets the potential loss of these resources, the effects will be similar to those of the Proposal but would occur in a different location. Offshore activities also may have adverse impacts to subsistence activities, recreation, and tourism.

IV.B.2.d. Fuel Switching

Consumers probably could switch to natural gas to heat their homes and businesses and for industrial uses. While natural gas production will create environmental impacts, these impacts would be at a lower level than those impacts normally associated with oil spills. Other alternative transportation fuels may constitute part of the fuel-substitution mix noted here. This mix depends on future technical and economic advances. At this time, no single alternative fuel appears to have the advantage.

IV.B.2.e. Other Substitutes

The Federal Government could impose regulations mandating other substitutes for oil. The most likely sectors to target would be transportation, electricity generation, or various chemical processes; however, there are many possibilities. The reader is referred to the paper *Energy Alternatives and the Environment* (USDOI, MMS, 2001a), which discusses many of the alternatives at too great a level of detail to reproduce in this EIS.

If this alternative (No Lease Sale) is adopted, the projected effects of the Proposal would not occur. Similar effects would occur elsewhere, but they would be in a different location and probably of a different magnitude. Natural resources in the Arctic Ocean and the Beaufort Sea still would be exposed to other ongoing oil and gas activities in the area, as analyzed in Section V on cumulative impacts.

IV.C. Analysis of Effects by Resource by Alternatives

This section analyzes effects by resource category for Alternative I and Alternatives III through VI. Alternative II - No Lease Sale is analyzed in Section IV.B. Each resource category includes an assessment of effects common to all alternatives (general areawide) and then a sale-by-sale and alternative-by-alternative assessment of effects. If the analysis is lengthy, a summary of the effects analysis is given.

This section looks at each of the 16 resources and analyzes both the effects common to all alternatives and specific effects to alternatives for each of the three sales on that resource. Under both discussions, analysts first address the exploration phase and then address the development and production phase of oil and gas leasing. The discussion of effects common to all alternatives begins with a discussion of the general areawide effects, addressing the disturbance aspect first. Disturbances are events (i.e., noise, construction, discharges) that likely would affect the resources in the Beaufort Sea. This is followed by a discussion of an oil spill. This event, although unlikely, could happen. Such an event depends on many things happening at the same time. In the unlikely event that a large oil spill occurs, it will impact the resource only if certain conditions exist at that time.

If the effects for alternatives or sales are identical or essentially the same, we do not repeat them. Instead, for each resource category, we group the alternatives and sales together when the effects are the same and provide a single analysis and conclusion. The groups are not consistent across resources, because the effects between alternatives and sales affect the resources differently.

We present the following four types of groups:

The effects of the alternatives are estimated to be essentially the same for all the alternatives, or combination of alternative. Justification or rationale that supports that statement is included. If all effects are estimated not to be the same, the exception(s) are discussed. If the analysts see no difference in causes and effects (for example, the disturbances, level and timing of noise events, likelihood of an oil spill, etc. are essentially identical), the analysts state that the effects are basically the same for every option in this group.

- Some of the causes of effects (disturbances, noise levels, timing, etc.) are estimated to be different, but the differences in effects are not measurable and the bottom-line effects of the alternatives/sales are essentially the same. Justification or rationale that supports that statement is included.

- Some of the causes of effects (disturbances, noise levels, timing, etc.) are estimated to be different and the effects are estimated to be different, but the differences in effects are not significant. The analysts list the observable and measurable differences and state the differences in impacts. If the discussion is lengthy, a summary is provided.
- A conclusion is provided at the end of the analysis for the effects common to all alternatives and the end of each alternative and/or group analysis.
- Some of the causes (disturbances, noise levels, oil spills) are estimated to be different, and the effects are estimated to be significantly different. The analysts list the observable and measurable differences and state the differences in impacts. If the discussion is lengthy, a summary is provided.

We are taking this approach to effects analysis in an attempt to not repeat the same bottom lines and to make it easier for the reader to follow.

IV.C.1. Water Quality

This section includes a general but detailed assessment of effects and then a brief sale-by-sale and alternative-by-alternative assessment of effects.

IV.C.1.a. Effects Common to All Alternatives

The agents associated with petroleum exploitation that are most likely to affect water quality are trace metals in permitted discharges of drilling muds and cuttings; turbidity from permitted dredging, filling, and other construction activities; and hydrocarbons from permitted discharges of produced waters and from oil spills. The effects of these agents on water quality are described in Sections III.A.5 and IV.B.1.a of the Sale 149 final EIS (USDOI, MMS, Alaska OCS Region, 1996); Sections III.A.5 and IV.B.1 of the Sale 144 final EIS (USDOI, MMS, 1996a); and Sections III.A.5 and IV.B.1 of Sale 170 final EIS (USDOI, MMS, 1998). The Sale 144 water quality section concluded in part that “contaminants from oil spills may exceed sublethal but not acute (toxic) levels over up to 200 km^2 for a few weeks; and contaminants from construction, island abandonment, and permitted discharges could exceed sublethal levels over a few square kilometers for several years” but that “regional water quality would not be affected” (USDOI, MMS, 1996a:IV-B-8). The Sale 170 water-quality section similarly concluded that “contaminants from permitted discharges over the life of the field and offshore construction activities for several years could exceed sublethal levels over a few square kilometers” but that “regional water quality would not be affected” (USDOI, MMS. 1998:IV-B-6). Those assessments are incorporated by reference into this EIS and augmented by the following additional information on trace metals, turbidity, and hydrocarbons.

Small Spills. The effects of small oil spills on water quality would be similar to but lower than those described for large spills. There likely would be an increase in the concentration of petroleum hydrocarbons in the water column, as described in detail in the Liberty final EIS (USDOI, MMS, Alaska OCS Region, 2002a:Section III.D.3.1). Hydrocarbons from small spills (3 barrels) could exceed the 0.015 parts per million chronic criterion for less than a day or two in an area less than 3 square kilometers (1.2 square miles). Thus, a small oil spill likely would not have any long-term degradational effect on overall water quality, but such spills that occur frequently (even though small) could result in local, chronic contamination.

IV.C.1.a(1) Effects of Permitted Discharges on Trace-Metal Concentrations

Trace metals would be added to the water by drilling muds and cuttings. Drilling muds used offshore of Alaska are limited to a low level of toxicity by the Environmental Protection Agency’s National Pollution Discharge Elimination System permits; in the current permit, the toxicity limit is 30,000-parts per million LC_{50} (concentration at which half the test organisms die within 4 days) (Environmental Protection Agency, 1995). The Environmental Protection Agency will prohibit drilling-mud and -cutting discharges in water depths less than 5 meters (2.7 fathoms) (Environmental Protection Agency, 1995) in future offshore exploration in the Arctic. The Environmental Protection Agency estimates this restriction should ensure that Federal water-quality criteria will be met at the edge of the mixing zone (USDOI, MMS, 1996a:Appendix H) and also should lessen the likelihood of elevated trace-metal concentrations persisting in shallow marine sediments (see Snyder-Conn et al., 1990). However, barium discharged in the drilling mud may persist in the marine sediments in deeper waters, and the concentrations may be more than 100 times greater than the concentrations that occur naturally in marine sediments. Natural concentrations of barium in Beaufort Sea coastal sediments range from 185-745 (Crecelius et al., 1991). The barium in drilling mud is in the form of barium sulphate, the mineral barite. Barite has a low solubility and relatively high specific gravity, which makes it useful as a material to add weight to a drilling mud. (The solubility of barium sulphate in cold, freshwater is about 0.00222 grams per liter, which is quite low when compared to the solubility of salt, which is 357 grams per liter.)

Based on the above information and additional analysis provided by Tetra Tech (1994), the Environmental Protection Agency determined that exploratory discharges are not likely to exceed applicable water-quality criteria outside of a 100-meter (328-foot) radius, or 0.03 square kilometer (7 acres) around each drilling discharge site. Thus, exploration drilling mud necessarily would fall into the slightly toxic to nontoxic range and would not pose an acute toxicity risk to the Beaufort Sea.

IV.C.1.a(2) Effects of Permitted Dredging and Filling on Turbidity

Additional turbidity would be created by trenching for subsea pipelines and by construction of gravel islands. Also, dredging might be used to prepare subsea berms for production platforms, but this latter use would be comparatively small. Pipeline installation would involve greater volumes of dredged materials and greater areal disturbance. The greatest effect on water quality from dredging would be to locally increase the turbidity by increasing the amount of suspended-particulate matter in the water column.

Suspended sediments have very low direct toxicity for sensitive species, with expected toxicity somewhere between that of a clay such as bentonite (LC_{50} greater than 7,500 parts per million for the eastern oyster) and that of calcium carbonate (LC_{50} greater than 100,000 parts per million for the sailfin molly) (see National Research Council (USA), 1983). These are very low toxicities, falling into the ranges generally described as slightly toxic to nontoxic. Direct toxicity from suspended sediments, therefore, has not been considered a regulatory issue, and toxic or acute marine standards have not been formulated by either the State of Alaska or the Environmental Protection Agency.

Both State standards and the Federal criterion are directed toward protecting biota from chronic stresses rather than from acute toxicity, but the limits are very different in formulation. One State standard is 25 nephelometric-turbidity units, and the Federal criterion and a second State standard are no more than a 10% decrease in the seasonally averaged compensation depth for photosynthetic activity. A third State standard is no more than a 10% reduction in maximum secchi disk depth.

Experiences with actual dredging or dumping operations in other areas show a decrease in the concentration of suspended sediments with time (2-3 hours) and distance downcurrent (1-3 kilometers [0.5-2 nautical miles]) from the discharge. Similarly, in the dredging operations associated with artificial-island construction and harbor improvement in mostly sandy sediments of the Canadian Beaufort Sea, the turbidity plumes also tended to disappear shortly after operations ceased; they generally extended a few hundred meters to a few kilometers (1 kilometer = 0.54 nautical mile) (Pessah, 1982).

The size, duration, and amount of turbidity depend on the grain-size composition of the discharge, the rate and duration of the discharge, the turbulence in the water column, and the current regime. However, turbidity likely would not extend farther than 3 kilometers (2 nautical miles) from the trenching and dumping operations.

Based on the analysis in this EIS, the increased turbidity from offshore construction activities would be local and short term, exceeding the chronic criterion of a 10% temporary change in photo-compensation depth over a distance of 3 kilometers or less (2 nautical miles or less), a local water-quality effect. The site-specific effects of any proposed pipeline dredging on water quality would be examined in future NEPA assessment, as it was in the EIS for the proposed Liberty Development in Foggy Island Bay (USDOI, MMS, Alaska OCS Region, 2002a).

Buried pipelines for future development might be elevated at landfalls on short gravel causeways (Section IV.A.2.b(3)(a)), and new logistical shore bases with short docks might be constructed (Section IV.A.2.b(2)(a)). The 1-mile (1.5-kilometer) long East Dock was constructed about 30 years ago. During that time, there have been many studies of nearshore water quality, but none have documented adverse water-quality effects (for example, circulation changes or temperature and salinity discontinuities) due to East Dock. Therefore, short docks probably would not affect hydrologic conditions, and subsequent NEPA analysis of any development proposals with docks would help to alleviate site-specific water-quality effects.

IV.C.1.a(3) Effects of Permitted Discharges of Produced Waters

Produced waters include formation water, injection water, and any chemicals added downhole or during the oil/water separation process; formation waters contain dissolved minerals and soluble fractions of the crude oil. Process equipment installed on the production platform usually separates the formation water from the oil and treats it for disposal. Treated formation waters may be discharged into the open ocean, reinjected into the oil-producing formation to maintain pressure, or injected into underground areas offshore. Discharge of formation waters would require an Environmental Protection Agency permit and would be regulated so that water-quality criteria, outside an established mixing zone, are not exceeded. To date, the Environmental Protection Agency has prohibited the discharge of formation waters into the Beaufort Sea in waters less than 10 meters (5.5 fathoms) deep. Reinjection and injection projects to maintain field pressure have become almost standard operating procedure. Of the 12 active oil fields in Alaska in 1994, 10 had water-injection projects (State of Alaska, Oil and Gas Conservation Commission, 1995). Formation waters from the Endicott and Northstar fields, the first offshore fields in the Beaufort Sea, are reinjected into the oil formation as part of a waterflood project.

Oil and grease concentrations in produced waters discharged into offshore areas from new facilities are limited to 42 milligrams per liter (42 parts per million) daily maximum and 29 milligrams per liter (29 parts per million) monthly average for exploration test discharges (40 CFR 435). The Environmental Protection Agency-approved analytical procedures used to measure oil and grease exclude lower molecular-weight hydrocarbons (less than C14), which pose most of the risk to the biota (National Research Council, 1985). The National Research Council has estimated that formation waters average 20-50 parts per million of lower molecular-weight hydrocarbons and 30 parts per million of higher molecular-weight hydrocarbons.

As oil is pumped from a field, the ratio of water to oil being produced generally increases. The ratio of water to oil for (1) Prudhoe Bay in 1971 was less than 0.01 while in 1994, the ratio was 1.26; (2) Kuparuk in 1982 was less than 0.01 while in 1994, the ratio was 1.14. Prudhoe Bay oil production began in 1969 and Kuparuk began oil production in 1981 (State of Alaska, Dept. of Natural Resources, 1971; State of Alaska, Oil and Gas Conservation Commission, 1982, 1994). The ratio of total water produced to total oil produced for (1) Prudhoe Bay is 0.35 after 26 years of production and (2) Kuparuk is 0.62 after 14 years of production (State of Alaska, Alaska Oil and Gas Conservation Commission, 1994). Assuming the water-to-oil ratio is between 0.35 and 0.62, the production of formation waters over the 20 years of production is estimated to range from about 122-415 million barrels. If the oil and grease content in the treated produced waters is 29 milligrams per liter (Environmental Protection Agency monthly average limit), the maximum amount of oil and grease in the produced waters is estimated to range from 562-1,913 metric tons (620-2,109 short tons) over 21 years.

If produced waters were discharged, the effect on water quality would be local but would last over the life of the field(s).

IV.C.1.a(4) Effects of Oil Spills on Hydrocarbon Concentrations

Hydrocarbon concentrations also would be affected by oil spills. This analysis of the effects of spills on water quality does not consider the benefits that oil-spill-cleanup measures could have in reducing the volume of oil.

After the *Exxon Valdez* oil spill of 0.258 million barrels, the concentrations of hydrocarbons in the water were not measured in the first 6 days of the spill. However, Wolfe et al. (1994) have used an earlier version of the MMS weathering model (Payne et al., 1984) to estimate water concentrations after the passage of the storm on the third day of the spill and arrived at an average value of 0.8 parts per million within the top 10 meters (5 fathoms) of the water, within the "effective" or discontinuous spill area. Wolfe et al. also summarized the actual measurements made in Prince William Sound. Seven to 11 days after the spill, residual concentrations ranged from 0.067-0.335 parts per million petroleum hydrocarbons, 0.0015 parts per million volatile organic analytes (mostly mononuclear aromatics), and 0.001-0.005 parts per million polynuclear aromatic hydrocarbons. Concentrations in Prince William Sound decreased to levels below the chronic criteria levels of concern (Section IV.A.1) to between 0.001 and 0.006 parts per million petroleum hydrocarbons and 0.0001 parts per million polynuclear aromatic hydrocarbons after 21-41 days. The concentration decreases within these timeframes were attributable to advection and dilution, not decomposition.

In restricted cold waters under very calm seas, the lack of vertical mixing and dilution can result in higher concentrations, 1-3 parts per million, within the top 1-3 meters that persist for a day (Baffin Island Oil Spill Project; Humphrey et al., 1987).

The concentrations of hydrocarbons in the water column are relatively low, because oil is only slightly soluble in water and vertical, and especially horizontal, dispersion and consequent dilution rapidly would decrease hydrocarbon concentrations for all but the largest spills in several hours. For spills of the magnitude of the *Exxon Valdez* spill, hydrocarbon concentrations could remain elevated above chronic criteria for as long as 10-20 days. Aromatic compounds are the most toxic constituents of crude oil, partly because they are the most soluble constituents. The highest rates of dissolution of aromatics from a slick and, consequently, accumulation in underlying water occur in the first few hours after a spill (Payne, 1987). The bulk of these volatile compounds are lost in less than 3 days; 3-day trajectories (Section IV.A.2) have been judged the appropriate length to approximate the initial, higher toxicity of spills in Alaskan waters.

If the spilled oil were of a composition similar to that of Prudhoe Bay crude, about 40% of the spilled oil could persist on the water surface, dispersed into individual tarballs after the slick disappeared. Photo-oxidation and biological degradation would continue to slowly decrease the residual amount of oil. Through 1,000 days, about 15% of the tarballs would sink, with an additional 20% of slick mass persisting in the remaining tarballs (Butler, Morris, and Sleeter, 1976, as cited by Jordan and Payne, 1980). Because of the drift of the oil over distances of hundreds or thousands of kilometers (1,000 kilometers = 540 nautical miles) during the slow process of sinking, individual, sunken tarballs would be extremely widely dispersed in the sediments, at concentrations on the order of some fraction of a tarball per hectare (per 2 acres).

Under ice, the volatile compounds from a spill would be more likely to freeze into the ice within hours to days rather than dissolve or disperse into the water underneath the ice. After the onset of melting, oil spilled under ice generally tends to reach the ice surface in an unweathered state. However, once formed, a hydrocarbon plume in the water column underneath the ice would persist above ambient standards and background over about a fivefold greater distance than under open water (see Cline, 1981).

The characteristics of the assumed 4,600-barrel oil spill (Table IV.A-5) in the summer and during meltout are shown in Table IV.A-6b. Based on these characteristics, the estimated concentration of oil dispersed in the water column for a summer spill after (1) 3 days is estimated to be 1.74 parts per million (assuming a 2-meter dispersal depth); (2) 10 days is estimated to be 0.33 parts per million (assuming a 5-meter dispersal depth); and (3) 30 days is estimated to be 0.07 parts per million (assuming a 10-meter dispersal depth). If the spill occurred in the spring during melting, the environmental conditions affecting the characteristics of a spill would be different from those of summer (Table IV.A-6b). The estimated concentration of oil dispersed in the water column for a meltout spill after (1) 3 days is estimated to be 5.65 parts per million (assuming a 2-meter dispersal depth); (2) 10 days is estimated to be 0.88 parts per million; and (3) 30 days is estimated to be 0.13 parts per million (assuming a 10-meter dispersal depth). The estimated high concentrations of oil associated with dispersal in the water column may represent an upper range of dispersed-oil concentrations reached during the first several days following a large spill. These concentrations are greater than the 0.015 parts per million that was assumed to be the total hydrocarbon chronic criterion and, after 3 days, less than the 1.50 parts per million that was assumed to be the acute criterion. Both the summer and meltout concentrations of oil that are estimated to be dispersed in the water column after 30 days, 0.07 and 0.13 parts per million, respectively, are within the range of concentrations reported for the larger *Argo Merchant* and *Amoco Cadiz* spills noted in the Sale 170 final EIS (USDOI, MMS, 1998). However, these concentrations are much greater that the previously noted concentrations of petroleum hydrocarbons, 0.001-0.006 parts per million, in Prince William Sound 21-41 days after the *Exxon Valdez* oil spill. The estimated concentration of dispersed oil in the water 30 days after both the summer and meltout spills is greater than 0.015 parts per million and indicates a relatively long period of time, perhaps about a month or more, before dilution of the dispersed oil reduces the concentrations below the chronic criterion.

Conclusion. Hydrocarbons from small spills could result in local, chronic hydrocarbon contamination; and hydrocarbons from a large oil spill could exceed the 1.5 parts per million acute toxic criterion during the first day of a spill and the 0.015 parts per million chronic criterion for up to a month in an area the size of a small bay. Other effects of the lease sales would not affect regional water quality, including the following three permitted activities: (1) The increased turbidity from permitted construction activities would be local and short term. (2) Trace metals from permitted discharges of drilling muds and cuttings over the life of the field could exceed sublethal levels over only a few square kilometers. (3) If produced waters were discharged, the effect on water quality would be local but would last over the life of the field(s).

Effectiveness of Mitigating Measures. Water-quality effects would be moderated partly by proposed Stipulation 7 - Pre-booming Requirements for Fuel Transfers. Even though the stipulation would not prevent a fuel spill, pre-booming would help with spill recovery and, therefore, would moderate water-quality effects. Also, the probable effects on water quality would be moderated partly by Stipulation 3 - Transportation of Hydrocarbons, and by ITL clause 15 - Information on Discharge of Produced Waters. The stipulation requires the use of pipelines, if feasible, rather than alternate transportation methods. Because less oil is spilled (per barrel transported) from pipelines than from barges, for example, the stipulation would moderate effects on water quality. The ITL clause advises lessees that the State prohibits discharge of produced waters within the 10-meter isobath, and that the Environmental Protection Agency could prohibit discharges on similar Federal tracts. Discharge restrictions in shallow water would moderate effects on water quality.

IV.C.1.b. Effects of Alternatives and Sales

IV.C.1.b(1) Effects of Alternatives I and III through VI for Sales 186 and 195 and Alternatives IV and V for Sale 202

The conclusion in Section IV.C.1.a would apply to these alternatives. The effects levels on water quality likely would not vary with these sales with alternatives for two main reasons. First, Section II.A.1 explains that most of the activities associated with the initial lease sales probably would be focused around Prudhoe Bay in the Near Zone (Sale 186) and then the Midrange Zone (Sale 195). Because the leased areas probably would be near the Prudhoe Bay infrastructure, exploration and development on existing leases in this area still would present the small risk to water quality, because the proposed deletions would not reduce substantially the risk of operations. Second, the deferred areas under these alternatives would be relatively small and would not reduce the chance of oil contact to nearshore water quality along the rest of the coast (Table A.2-27).

Sale 202 with Alternatives III (Barrow Subsistence Whaling Deferral) and VI (Eastern Deferral), however, likely would have different levels of effects on water quality for the following two reasons: the alternatives would delete relatively large areas, and (2) the areas that to be developed in Sale 202 could include the far western and eastern Beaufort Sea. The nearshore water quality in these areas is especially important, because bowhead whales sometimes feed there (Griffiths, Richardson, and Thomson, 2001). The level of effects for Sale 202 with these two alternatives is described in the following Sections IV.C.1.b(2) and (3).

Conclusion. Hydrocarbons from small spills could result in local, chronic hydrocarbon contamination; and hydrocarbons from a large oil spill could exceed the 1.5 parts per million acute toxic criterion during the first day of a spill and the 0.015 parts per million chronic criterion for up to a month in an area the size of a small bay. Other effects of the lease sales would not affect regional water quality, including the following three permitted activities. The increased turbidity from permitted construction activities would be local and short term. Trace metals from permitted discharges of drilling muds and cuttings over the life of the field could exceed sublethal levels over only a few square kilometers. If produced waters were discharged, the effect on water quality would be local but would last over the life of the field(s).

IV.C.1.b(2) Effects of Alternative III for Sale 202

Exploration and development might occur far to the west under Sale 202. Exploratory drilling operations were conducted in this area at the Cabot Prospect during 1991 without noticeable effects on water quality. Deferral of the Barrow subsistence-whaling area would reduce slightly the chance of oil contact to the water quality in the bowhead feeding area near Barrow. The chance of contact to nearshore water from about Point Barrow east to Pitt Point (Land Segments 25-31) would be reduced by 1-15% (assuming contact occurs within 30 days during the summer, Table A.2-27:LA2). However, the chance of contact to nearshore water quality east of the deferral would be about the same with or without the deferral (Table A.2-27:LA1, LA3-LA18, P1- -P13).

Conclusion: This alternative would reduce the risk that hydrocarbons from a large oil spill could exceed the 1.5 parts per million acute toxic criterion for several days in nearshore waters near Barrow. Other effects would be similar to Sale 202 without a deferral (Alternative I). The increased turbidity from permitted construction activities would be local and short term. Trace metals from permitted discharges of drilling muds and cuttings over the life of the field could exceed sublethal levels over only a few square kilometers. If produced waters were discharged, the effect on water quality would be local but would last over the life of the field(s).

IV.C.1.b(3) Effects of Alternative VI for Sale 202

Exploration and development might occur far to the east with Sale 202. Exploratory drilling operations were conducted in this area at the Aurora Prospect during 1988 without noticeable effects on water quality. Deferral of the area southeast of Kaktovik would reduce slightly the chance of oil-spill contact to the area. The chance of contact to nearshore water quality from about Beaufort Lagoon east to Herschel Island (Land Segments 49-55) would be reduced 2-11% (assuming contacts occur within 30 days during the summer, Table A.2-27:LA18). However, the chance of contact to nearshore water quality to the west of Beaufort Lagoon (Table A.2-27:Land Segments 25-48) would be about the same as described for Sale 202 without a deferral.

Conclusion: The deferral would reduce the risk that hydrocarbons from a large oil spill could exceed the 1.5 parts per million acute toxic criterion for several days in nearshore waters of the bowhead whale feeding area near Kaktovik. Other effects would be similar to Sale 202 without a deferral (Alternative I). The increased turbidity from permitted construction activities would be local and short term. Trace metals from permitted discharges of drilling muds and cuttings over the life of the field could exceed sublethal levels over only a few square kilometers. If produced waters were discharged, the effect on water quality would be local but would last over the life of the field(s).

IV.C.2. Lower Trophic-Level Organisms

This section begins with a general but detailed assessment of effects and ends with a sale-by-sale and alternative-by-alternative assessment of effects.

IV.C.2.a. Effects Common to All Alternatives

Lower trophic-level organisms, which include planktonic, epontic (under ice), and benthic forms, are described in Section III.B.1. Aspects of the proposed lease sales that may affect lower trophic-level organisms include discharges, construction activities, and oil spills. The effects of discharges, construction, and spills on lower trophic-level organisms have been discussed in the EIS's for Beaufort Sea Sale 144 and Sale 170). The Sale 144 EIS concluded in part that "each of two assumed 7,000-bbl oil spills is estimated to have lethal and sublethal effects on <1 percent of the phytoplankton and zooplankton populations in the sale area" and that "recovery in embayment areas is expected to take 1 to 2 weeks" (USDOI, MMS, 1996a:IV-B-15). The Sale 170 EIS concluded in part that "discharges are estimated to adversely affect <1 percent of the benthic organisms in the sale area" and that "recovery is expected within a year after the discharges cease" (USDOI, MMS, 1998:IV.B-11). The following analysis incorporates and updates the Sale 144 and 170 assessments in terms of the proposed lease sales.

IV.C.2.a(1) Effects of Permitted Discharges

The types of material discharged during exploratory operations usually include drilling muds and cuttings, although there usually are restrictions on such discharges in shallow water, under ice, and near special kelp communities. During production operations, there might be discharges of produced water; however, recent developments in the Beaufort Sea (for example, Endicott and Northstar) have reinjected the produced waters. The water-quality section explains that the Environmental Protection Agency has determined that exploratory discharges are not likely to exceed applicable water-quality criteria outside of a 100-meter (329-foot) radius around each drilling discharge site. In spite of the 100-meter zone of potential contamination, there is no evidence of the effects on lower trophic-level organisms. An extensive review found no evidence of effects on plankton from drilling muds (Neff, 1991), and benthic organisms near Beaufort Sea drilling sites have accumulated neither petroleum hydrocarbon nor heavy metals, as shown by monitoring during the 1980's, 1999, 2000, and 2002 (Brown, Boehm, and Cook, 2001). Heavy metals in Beaufort Sea marine mammals and their prey are the focus of an ongoing study at the University of Alaska Fairbanks (Dehn et al., 2002). The study found differences in the total mercury in the livers of ringed and bearded seals from the Alaskan and Canadian Arctic. As described in Section III.B.1.a, they suggested that those differences were related to differences in the prey, because ringed seals eat mostly pelagic organisms (i.e., euphausiids) and bearded seals eat benthic and epibenthic organisms. The variations were observed over broad regions of the arctic rather than near and far from areas in which there had been discharges.

Based on the 1,000-meter seafloor area that might be affected temporarily by drilling discharges, less than 1% of the benthic organisms in the sale area and none of its plankton probably would be affected. Benthic organisms within 1,000 meters of a platform likely would experience temporary sublethal effects due to trace metals in drilling muds. Within this distance, some changes likely would occur in the species composition of affected benthic areas. Recovery of the affected benthic communities likely would occur within 1 year after the termination of discharges.

Produced waters contain small amounts of hydrocarbons that might affect plankton. Recent studies by Shirley and Duesterloh (2002) have shown that toxic effects on zooplankton are increased manyfold by the presence of ultraviolet radiation near the water surface. As noted in the section on water quality, the discharge of formation waters would be regulated by the Environmental Protection Agency to avoid toxicity outside an established mixing zone. The effects of hydrocarbons on plankton are discussed further in the following section on oil-spill effects.

IV.C.2.a(2) Effects of Permitted Disturbances

Disturbance of benthic communities could be caused by ocean-bottom cable for seismic surveys, placement of bottom-founded platforms, construction of artificial islands and short docks, and/or pipeline dredging. Ocean-bottom cables for seismic surveys could affect benthic kelp communities such as the Boulder Patch. However, in most portions of the Beaufort Sea where ice gouges the seafloor, the effect of ocean-bottom cables could not be detected. Whenever proposals are submitted for specific seismic programs, the presence of kelp communities and the site-specific effects would be assessed.

Placement of bottom-founded production platforms, construction of artificial islands and short docks, and pipeline dredging would affect benthic organisms in the immediate site and downcurrent. Construction likely would have little or no effect on planktonic or epontic communities in the Beaufort Sea multiple-sale area. Construction could affect benthic organisms by physically altering the benthic environment, increasing sediments suspended in the water column, and killing organisms directly through mechanical actions (Lewbel, 1983). Platform placement and pipeline laying likely would kill the less-mobile benthic organisms in their path. Recovery likely would occur within 3 years. The more mobile organisms likely would avoid these areas of disturbance and not be affected. On the beneficial side, platforms add a three-dimensional structure to the marine environment, thereby providing additional habitat for those benthic organisms that require a hard, secure substrate for settlement. Colonization time likely would be a decade. Hence, the overall effect of a platform would be to alter species diversity near the platform in favor of organisms requiring hard substrates over those that do not. Buried pipelines for future development might be elevated at landfalls on short gravel causeways (Section IV.A.2.b(3)(a)) and docks, such as the one proposed for the Point Thompson development, might be constructed for new logistical shore bases (Section IV.A.2.b(2)(b)). The 1-mile (1.5-kilometer) long East Dock was constructed about 30 years ago. During that time, there have been many studies of nearshore water quality, but none have documented adverse effects on water quality or lower-trophic level organisms due to East Dock. Therefore, short docks and causeways probably would not affect hydrologic conditions, and subsequent NEPA analysis of any development proposals with docks would help to alleviate site-specific water-quality effects.

Most locations within the sale area support few benthic organisms. No construction activities likely would occur in areas where benthic communities are more concentrated (for example, Boulder Patch kelp habitat). Less than 1% of the immobile benthic organisms in the multiple-sale area would be affected by platform and pipeline construction associated with the exploration and development scenario. Because of the small area affected by platform and pipeline construction and the low density of benthic marine organisms in the sale area, construction likely would have little adverse effect on lower trophic-level communities.

IV.C.2.a(3) Effects of a Large Oil Spill

This section assesses the probable effects of accidental oil spills on planktonic and epontic communities first and then on benthic communities. The effects of oil spills on the coastal organisms are assessed in Section IV.C.9 – Vegetation and Wetlands.

IV.C.2.a(3)(a) Spill Effects on Planktonic and Epontic Communities

Some hydrocarbons are produced naturally by phytoplankton, and many have been found to be the same as, or similar to, those found in crude oil (Davenport, 1982). Therefore, some hydrocarbons are considered a normal part of the chemical makeup of phytoplankton. Hydrocarbons occurring in the water column that are similar to those occurring naturally in phytoplankton likely would have little effect on phytoplankton. Other petroleum-based hydrocarbons (for example, chlorinated hydrocarbons) are not of natural origin and may have adverse effects on some phytoplankton, even at low concentrations.

Effects on phytoplankton vary widely, depending on the concentration and type of oil or compounds used in the experiments and on the species being tested (National Research Council, 1985). Nevertheless, general patterns do exist, and both laboratory and field studies have shown that hydrocarbons typically inhibit phytoplankton growth at higher concentrations but sometimes enhance growth at lower concentrations. Growth inhibition and/or mortality in phytoplankton have been noted to occur at hydrocarbon concentrations of 1-10 parts per million. Growth enhancement has been noted at concentrations of less than or equal to 0.1 parts per million (National Research Council, 1985). In terms of data collected during an oil spill or field study, large-scale adverse effects on plankton have not been reported (National Research Council, 1985). Observations of phytoplankton biomass and primary productivity following the *Tsesis* spill (in Sweden in 1977) revealed no significant differences between noncontaminated and contaminated areas (Johansson et al., 1980, as cited in National Research Council, 1985:442). In cases where studies have been conducted following small or even large oil spills, this lack of substantial adverse effects on plankton populations due to spilled oil is common. Even if we assume that a large number of phytoplankton are contacted by an oil spill in an open-ocean area, the regeneration time of the cells (9-12 hours) and the rapid replacement of cells from adjacent waters likely would preclude any major effect on phytoplankton communities (National Research Council, 1985). Further, the vertical distribution of most phytoplankton in the water column typically is below the area where it would be adversely affected by hydrocarbons associated with an oil spill. For these reasons, a large oil spill likely would not have a significant effect on phytoplankton. Recovery from the effects of a large oil spill likely would require less than 2 days.

The effects of petroleum-based hydrocarbons on zooplankton have been observed in the field at spill sites and also in the laboratory. Some planktonic animals have the ability to metabolize and detoxify some types of hydrocarbons, and that this ability varies between species. The observed vulnerability of zooplankton to hydrocarbons (dispersed and dissolved) in the water column varies widely. Lethal hydrocarbon concentrations for zooplankton range from about 0.05-10 parts per million, which is similar to that expected for other small floating organisms (for example, fish eggs and larvae and crustacean larvae). Sublethal crude oil concentrations for zooplankton range from about 1 part per million to well below 0.05 part per million (National Research Council, 1985). Sublethal effects include lowered feeding and reproductive activity, altered metabolic rates, and community changes. Whether effects are lethal or sublethal depends on exposure time, hydrocarbon toxicity, species, and lifestage involved (early stages are the most sensitive).

Field observations of zooplankton communities at oil spills and in chronically polluted areas have shown that the communities were affected, but that these effects appeared to be short lived (Johansson et al., 1980). Individuals within chronically polluted areas have experienced direct mortality, external contamination by oil, tissue contamination by aromatic constituents, inhibition of feeding, and altered metabolic rates. However, because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity, zooplankton communities exposed to oil spills or chronic discharges in open-water areas appear to recover (National Research Council, 1985). In areas where flushing rates and water circulation are reduced, the effects of an oil spill likely would be greater, and the recovery of zooplankton biomass and standing stocks likely would take somewhat longer.

Several studies with freshwater organisms have shown that sunlight makes polycyclic aromatic hydrocarbons more toxic. A recent study by Pelletier et al. (1997) showed that marine invertebrates also are affected more by polycyclic aromatic hydrocarbons under ultraviolet radiation. The enhanced phototoxicity was more obvious with heavy oils, such as Liberty crude, than with light diesel oil. The authors noted that ultraviolet radiation would not penetrate turbid coastal water. These results have been corroborated by two other studies. Shirley and Duesterloh (2002) also observed increased oil toxicity to copepods in the presence of ultraviolet radiation. Gibson et al. (2000) conclude that ultraviolet radiation influences on food-web processes in the Arctic Ocean are likely to be small relative to the effects caused by variation in the concentrations of natural ultraviolet radiation-absorbing compounds that enter the arctic basin via its large rivers.

In general, the effect of the oil associated with a large oil spill would depend on the amount of sunlight, wind speed and duration, air and water temperature, and the composition of the oil. However, based on the assumptions associated with weathering of Prudhoe Bay crude oil (Tables IV.A-6a and IV.A-6b), within 10 days of a spill (winter), 10% of the oil would have evaporated, 57% would remain on the surface, and 32% would be dispersed into the water column. Dispersed and/or dissolved oil in the water column has the greatest potential of adversely affecting phytoplankton and zooplankton. Surface oil and that fraction that evaporates rarely would contact plankton, because plankton typically are beneath the surface.

A week after the *Exxon Valdez* oil spill, the concentration of hydrocarbons in the water column were well below (about 10-1,000 times below) the levels known to be toxic and below levels that cause sublethal effects in plankton. Further, the concentrations returned to background levels (0.20 parts per billion) in less than a month (Neff, 1991). However, because the water samples were taken a week or more after the spill, it is unclear what the actual hydrocarbon concentrations were during and immediately following the *Exxon Valdez* spill. Thus, for purposes of analysis, hydrocarbon concentrations in the water column during and immediately following an oil spill are conservatively assumed to be initially harmful to phytoplankton and zooplankton (exceeding 0.1 parts per million but for less than 5 days; Meyer, 1990).

The likelihood of plankton populations being adversely affected by an oil spill would be greatest during the summer in the coastal band of high production (Figures III.B-1a and III.B-1b). In the unlikely event that a large spill occurs during this period, less than 1% of the plankton in the sale area is estimated to experience sublethal and/or lethal effects. The 1% is relative small compared to the observed 10% inter-annual variation in zooplankton prey of bowhead whales (Griffiths and Thomsom, 2002). Further, phytoplankton likely would recover within 2 days through regeneration and replacement from adjacent waters, whereas zooplankton recovery may require up to 1 week. Recovery in embayments where water circulation is reduced likely would require up to 2 weeks. Small oil spills might adversely affect plankton in the area immediately around the spill, but they likely would not have a measurable effect at the population level. If oil were spilled under the ice and trapped directly beneath it, most epontic organisms living there likely would be killed. Oil trapped in this way probably would be encapsulated within the ice with increasing time. If oil on, in, or under the ice is released during breakup, the oil would continue to affect the planktonic community.

IV.C.2.a(3)(b) Spill Effects on Benthic Communities

Many benthic species are fed upon by higher food-web species, such as marine fishes, birds, and mammals. Benthic flora, such as that found in the Boulder Patch, also provides shelter for small fish and invertebrates and decreases erosion and turbidity. Hence, any significant effect on benthic-level organisms (natural or unnatural) likely would have an effect on higher trophic levels as well.

In the marine environment, hydrocarbons resulting from an oil spill are broken up by wave action into floating surface oil, dispersed and dissolved oil within the water column, and oil that is incorporated into bottom sediments. Marine plants and animals are affected most by floating surface oil and oil that is being incorporated into bottom sediments through wave action. In marine environments that have distinct intertidal and subtidal floral and faunal communities, the most persistent effects often occur when intertidal and shallow subtidal benthic communities are contacted by oil, particularly in areas where water circulation is restricted (for example, bays, estuaries, mud flats, and rock-armored shorelines).

IV.C.2.a(3)(b)1) Benthic Plants

What is known about the effect of crude oil on marine plants and shoreline substrates has come largely from observations following oil spills. Effects vary considerably depending on the substrate, plant species, type and concentration of oil, and the timing and duration of exposure. Following the *Exxon Valdez* oil spill, significant hydrocarbon concentrations were found in intertidal sediments at heavily oil sites, and the oil appeared to move into the shallow subtidal zone within a few years (Wolfe et al., 1993). Ongoing studies of the *Exxon Valdez* spill show that oil has persisted in the shoreline sediments for more than a decade (www.oilspill.state.ak.us/facts/lingeringoil.html). In spite of the lingering oil, plant recolonization of the heavily oiled intertidal rocky habitat began the first year after the spill (Duncan, Hooten, and Highsmith, 1993; van Tamelen and Stekoll, 1993), and complete recovery likely occurred within 6 years. The subtidal macroalgae populations in Prince William Sound, including the kelp *Laminaria*, were studied 1 year after the *Exxon Valdez* spill (Dean, Stekoll, and Smith, 1996). The investigators found that within a year of the spill, there were no differences in the total density, biomass, or percentage cover of macroalgae between oiled and control sites. Most areas that were oiled by the *Exxon Valdez* spill but not high-pressure washed recovered to prespill conditions by 1991. Further, all dominant flora and fauna (except barnacles) that were high-pressure washed suffered 60-100% mortality and have not recovered to date (Houghton et al., 1996). Hence, the high-pressure shoreline treatment associated with the *Exxon Valdez* spill appears to have had as great an effect on shoreline plants as the oil itself. In summary, the benthic plants in areas that were substantially affected by the *Exxon Valdez* oil recovered to prespill conditions within 3 years but small amounts of the oil have persisted in the shoreline sediments for more than a decade in spite of cleanup responses.

However, in the Beaufort Sea there is no intertidal zone in the traditional sense. This is due to the annual predominance of shorefast ice, which precludes marine plant life and most fauna along the shoreline, leaving macrophytes only above the tideline or below a depth of 2 meters. The effects of offshore oil spills on saltmarsh vegetation and wetlands above the tideline are assessed in Section IV.C.9.a(2)(b). Below the 2-meter depth, marine macrophytes grow in only a few locations in the Beaufort Sea, such as the Boulder Patch community in Stefansson Sound. The estimated effect of a large oil spill on subtidal marine plants in the Beaufort Sea area depends on the type and amount of oil reaching them. The main type of oil that could reach these marine plants in the subtidal zone (most are 5-10 meters deep) would be highly dispersed oil having no measurable toxicity occurring as a result of heavy wave action and vertical mixing. The amount and toxicity of oil reaching subtidal marine plants likely would be so low as to have no measurable effect on them.

Even though crude oil probably would not mix down into the water column and affect marine plants, even small spills of refined petroleum such as diesel fuel could be mixed deeper into the water column. Diesel fuel is used routinely to provide auxiliary power for offshore drilling and is transported to drilling sites in fuel barges. Most small spills on the OCS were of such stored oil, either crude or fuel oil (Anderson and

LaBelle, 1994). The specific effects of spilled diesel fuel on kelp communities is assessed in Section III.C.2.e(2)(b) of the Liberty final EIS (USDOI, MMS, Alaska OCS Region, 2002a).

IV.C.2.a(3)(b)2) Benthic Invertebrates

The dominant marine invertebrates in the Beaufort Sea area include gastropods, mollusks, annelids, echinoderms, and crustaceans. Crude oil can have lethal effects on marine invertebrates from either a short-term exposure to high hydrocarbon concentrations or a long-term exposure to lower hydrocarbon concentrations. Laboratory studies indicate that oil concentrations ranging from 1-4 parts per million can be lethal to both adult and larval crab and shrimp after 96 hours of exposure (Starr, Kuwada, and Trasky, 1981). Large oil spills often have resulted in mortality of bivalves (Teal and Howarth, 1984), which are fed on by many species of marine birds, fishes, and mammals. Effects on bivalves can be almost immediate, but declines in numbers may continue for years (6 years) (Thomas, 1976).

Studies following the *Exxon Valdez* oil spill in 1989 showed that significant hydrocarbon concentrations in shoreline sediments were found at heavily oiled sites, followed by an apparent migration of the oil into the shallow subtidal zone in 1991 (Wolfe et al., 1993). However, significant concentrations of oil were not found in the subtidal zone. Regarding the toxicity of shoreline areas contaminated by the spill, Gilfillan et al. (1993) have shown that the toxicity of oiled intertidal sediments declined rapidly after the spill. Within 18 months, about 75% of the oiled shoreline had recovered. In fact, toxicological results indicate that the oiled shoreline was at toxic hydrocarbon levels for only a few months to 1 year. The remaining hydrocarbons were found to be generally nontoxic and are thought to serve as a food source for some biota (for example, bacteria).

For purposes of analysis, it is assumed that some of spilled oil would drift into shallow water. Because of the amount of time elapsed in reaching shallow water (several days), the more toxic hydrocarbon fractions would have evaporated and likely would not have toxic effects on benthic invertebrates that seasonally inhabit the shoreline. As mentioned earlier, the predominance of shorefast ice along the shoreline of the Beaufort Sea precludes all but seasonal shoreline invertebrate fauna down to about 2 meters in water depth. Subtidal organisms deeper than this also would not be contacted, because they live below the zone where oil is likely to measurably affect them.

Hence, the only marine invertebrates likely to be contacted by floating or dispersed oil associated with an oil spill would be those closest to the surface. These include zooplankton (such as copepods, euphausiids, mysids, and amphipods) and also the larval stages of marine invertebrates such as annelids, mollusks, and crustaceans. Because of similarities in habitat use and distribution, the percentage of marine invertebrate larva contacted by floating or dispersed oil is likely to be similar to that expected for plankton (i.e., less than 1%). Due to their wide distribution, large numbers, and rapid rate of regeneration, the recovery of marine invertebrate larva likely would require less than a month. Recovery in embayments where water circulation is reduced likely would require up to a year. Small oil spills likely would have a perceptible effect on lower trophic-level organisms at the population level.

Aside from the probable effect of spills to the coastline in general, the risk to the Arctic National Wildlife Refuge coastline in particular has been estimated. The coastline would be vulnerable to offshore spills mainly during the summer open-water period; during the rest of the year, the coastline probably would be buffered from offshore spills by the band of landfast ice. The Oil-Spill-Risk Analysis conditional probabilities for summer (Tables A.2-85 through A.2-90) indicate that the risk to the Refuge would be highest, of course, for any inshore spill in the eastern Alaskan Beaufort Sea. The specific probability that a spill from various offshore locations would contact the Refuge's coastline within 30 days is given in Table A.2-87. The table shows that the probability would be 38% or less from all hypothetical launch areas except one in Launch Area 18, which corresponds with the nearshore lease tracts in the eastern Alaskan Beaufort Sea. A summer spill in that area is estimated to have a 49% probability of contacting the Refuge's coastline within 30 days (Table A.2-87). As discussed further in Section IV.C.2.b, deferral of leasing in the eastern Alaskan Beaufort Sea would not eliminate the risk to the Refuge's coastline but would lower the maximum risk by about 25%. Specifically, the maximum probability that a summer spill would contact the coastline of the Arctic National Wildlife Refuge within 30 days would drop from 49% to 38% (Table A.2-87).

Summary. Resource-development activities could affect lower trophic-level organisms (phytoplankton, zooplankton, epontic, and benthic) by exposing them to drilling discharges, seismic surveys, construction, and petroleum-based hydrocarbons. In general, effects associated with the low and high ends of the resource-recovery range likely would be similar in most cases (one large oil spill was evaluated for both). Drilling discharges are estimated to affect less than 1% of the benthic organisms in the sale area and none of its plankton. Affected benthic organisms likely would experience sublethal effects, but some (mostly immature stages) would be killed. Recovery likely would occur within 1 year after the discharge ceases. Seismic surveys likely would have little or no effect on lower trophic-level organisms. Construction likely would have little or no effect on plankton communities. Less than 1% of the immobile benthic organisms would be affected by construction (mostly sublethal effects). Immobile benthic communities affected by pipeline construction likely would recover in less than 3 years. Marine organisms needing a hard substrate for settlement likely would benefit from the production platforms (particularly those associated with the high end of the resource-recovery range) and to colonize them within 2 years.

An oil spill is estimated to have sublethal and lethal effects on less than 1% of the plankton in the coastal band of high concentration. Recovery likely would require 2 days for phytoplankton and up to 1 week for zooplankton. Recovery within the affected embayments likely would require up to 2 weeks. During a winter oil spill, if oil were trapped under the ice, epontic organisms living there probably would be killed. Less than 5% of the epontic community in the sale area likely would be affected this way. Although crude oil probably would not mix down into the water column and affect benthic organisms, spills of refined petroleum such as diesel fuel could be mixed deeper into the water column, potentially affecting kelp communities. The Oil-Spill-Risk Analysis conditional probabilities for summer indicate that risk to the shoreline is low in general, and that the risk to the Arctic National Wildlife Refuge's coastline specifically would be highest for any inshore spill in the eastern Alaskan Beaufort Sea. If a spill did contact the shoreline, small amounts of the spilled oil would probably affect the shoreline for more than a decade in spite of cleanup responses.

Conclusion. Lower trophic-level organisms would be affected by discharges, disturbances, and spills. Permitted drilling discharges probably would affect benthic organisms within 1,000 meters of the discharge points, and recovery likely would occur within a year. Platform and pipeline construction is estimated to adversely affect less than 1% of the immobile benthic organisms in the sale area, and recovery likely would occur within 3 years. Special kelp communities could be protected from construction effects by required benthic surveys. In the unlikely event that a large oil spill occurs, it is estimated to affect only a small portion of the planktonic and/or epontic organisms in the sale area. Recovery of plankton likely would occur within a week (2 weeks in embayments). Spills of refined petroleum in relatively shallow water could affect the benthos, including kelp communities. The Oil-Spill-Risk Analysis indicates that the risk to the coastline is low in general, and that the risk to the coastline of the Arctic National Wildlife Refuge specifically would be highest for any inshore spill in the eastern Alaskan Beaufort Sea. If a spill did contact the shoreline, a small amount of spilled oil probably would persist in sediments for more than a decade.

Effectiveness of Mitigating Measures: Spill responses would moderate some of the effects. Responses could recover most of any spilled oil on a solid-ice cover and some of any oil in open water, reducing the effects on lower trophic-level organisms; but oil in broken ice would be difficult to recover. Spill responses to oil on the shoreline probably would affect the habitat as much as the oil itself. The probable effects on lower trophic-level organisms would be moderated also by proposed Stipulation 7 - Pre-Booming Requirements for Fuel Transfers; by Stipulation 1 - Protection of Biological Resources; and by ITL clauses 5 - Information on River Deltas and 11 - Sensitive Areas to be Considered in Oil-Spill-Contingency Plans. Stipulation 1 states that the agency might require additional surveys of special biological resources and, depending on the results, modification of operations to ensure protection. The stipulation would moderate effects on kelp habitats. The Boulder Patch is one of the specified biological resources to be considered in contingency plans, and any effects to the Boulder Patch would be moderated by this ITL clause. Proposed Stipulation 7 about pre-booming during fuel transfers would moderate possible effects on lower trophic-level organisms. Even though the stipulation would not prevent a fuel spill, pre-booming would help with spill recovery and, therefore, would moderate effects on lower trophic-level organisms. The ITL clauses 5 and 11 would require preplanning of spill responses in sensitive areas, including river deltas that are biologically rich and where spilled oil would persist for about a decade.

IV.C.2.b. Effects of Alternatives and Sales

IV.C.2.b(1) Effects of Alternative I and III through VI for Sale 186 and 195 and Alternatives III, IV, and V for Sale 202

The conclusion in Section IV.C.2.a applies to these alternatives and sales. The effects levels on lower trophic-level organisms likely would not vary with these sales and alternatives for two main reasons. First, some of the leased areas probably would be near the Prudhoe Bay infrastructure; exploration and development on existing leases in this area still would present a small risk to lower trophic-level organisms, even with the alternative deletions. Second, the deferred areas under these alternatives would be relatively small and would not reduce the oil-spill risk to the organisms.

However, Alternative VI (Eastern Deferral) likely would have different levels of effects on lower trophic-level organisms for the following two reasons: (1) the alternative would delete relatively large areas, and (2) the areas that would be developed in Sale 202 could include the eastern portion of the Alaskan Beaufort Sea. The coastal production in these areas is especially important, because bowhead whales sometimes feed there (Griffiths, Richardson, and Thomson, 2001). The levels of effects for Sale 202 with these two alternatives are described in Section IV.C.2.b(2).

As assessed in Section IV.C.2.a above, the coastline would be vulnerable to offshore spills mainly during the summer open-water period; during the rest of the year, the coastline probably would be buffered from offshore spills by the band of landfast ice. The probability that a summer spill from various offshore locations would contact the coastline of the Arctic National Wildlife Refuge within 30 days is given in Table A.2-87. The table includes the probability for spills in hypothetical Launch Area 18, which corresponds with the eastern Deferral area and Kaktovik Subsistence Whale Deferral area combined. A summer spill from this launch area is estimated to have a 49% probability of contacting the Refuge's coastline within 30 days (Table A.2-87). Deferral of leasing in these two areas combined would not eliminate the risk to the Refuge's coastline but would lower the maximum risk by about 25%. Specifically, the maximum probability that a summer spill would contact the coastline of the Arctic National Wildlife Refuge within 30 days would drop from 49% to 38% (Table A.2-87).

Conclusion: Permitted drilling discharges are estimated to adversely affect less than 1% of the benthic organisms in the sale area. The organisms likely would recover within a year. Platform and pipeline construction is estimated to adversely affect less than 1% of the immobile benthic organisms in the sale area. Recovery likely would occur within 3 years. Unusual kelp communities could be protected from construction effects by required benthic surveys. The communities likely would colonize and benefit slowly from some new gravel islands. In the unlikely event that a large oil spill occurs, it is estimated to have lethal and sublethal effects on less than 1% of the planktonic organisms and (assuming a winter spill) less than 5% of the epontic organisms in the sale area. Recovery of plankton likely would occur within a week (2 weeks in embayments). Also, a large spill of refined fuel oil likely would have lethal and sublethal effects on less than 1% of the benthic invertebrates in shallow areas. Recovery likely would occur within a month (within a year where water circulation is significantly reduced). A summer spill from the Eastern Deferral area and Kaktovik Subsistence-Whaling Deferral area combined is estimated to have a 49% probability of contacting the coastline of the Arctic National Wildlife Refuge within 30 days. Deferral of leasing in these two areas combined would not eliminate the risk to the Refuge's coastline but would lower the maximum risk by about 25%.

IV.C.2.b(2) Effects of Alternative VI for Sale 202

Exploration and development might occur far to the east with Sale 202; deferral of the area south and east of Kaktovik would reduce slightly the oil-spill risk to the area. The chance of contact to nearshore water quality from about Beaufort Lagoon east to Herschel Island (Land Segments 49-55) would be reduced 2-11% (assuming contacts occur within 30 days during the summer [Table A.2-27:LA18]). However, the chance of contact to the coastal band of high production to the west of Beaufort Lagoon (Table A.2-27, Land Segments 25-48) would be about the same as those described for Sale 202 without a deferral.

The probability that a summer spill from various offshore locations would contact the coastline of the Arctic National Wildlife Refuge in particular within 30 days is listed in Table A.2-87. As explained in

Section IV.C.2.b(1), the table includes the probability for spills in hypothetical Launch Area 18, which correspond with the Eastern Deferral area and Kaktovik Subsistence-Whaling Deferral area combined. A summer spill from this launch area is estimated to have a 49% probability of contacting the Refuge's coastline within 30 days. Deferral of leasing in these two areas combined would not eliminate the risk to the Refuge's coastline, but would lower the maximum risk by about 25%. Specifically, the maximum probability that a summer spill would contact the Refuge's coastline within 30 days would drop from 49% to 38% (Table A.2-87).

Conclusion. The deferral would reduce the risk that hydrocarbons from a large oil spill would contaminate (Section IV.C.1.b) the area south and east of Kaktovik for several days. Other effects would be similar to those described for Sale 202 without a deferral (Alternative I). Permitted drilling discharges likely would adversely affect less than 1% of the benthic organisms in the sale area. The organisms likely would recover within a year. The Aurora Prospect in this area was explored during 1988 with no noticeable effects of discharges on lower trophic-level organisms. Platform and pipeline construction likely would adversely affect less than 1% of the immobile benthic organisms in the sale area. Recovery likely would occur within 3 years. Unintentional construction effects on unusual kelp communities could be avoided by required benthic surveys (Stipulation 1). A summer spill from the Eastern Deferral area and Kaktovik Subsistence-Whaling Deferral area combined is estimated to have a 49% probability of contacting the coastline of the Arctic National Wildlife Refuge within 30 days. Deferral of leasing in these two areas combined would not eliminate the risk to the Refuge's coastline, but would lower the maximum risk by about 25%.

IV.C.3. Fishes

IV.C.3.a. Effects Common to All Alternatives

IV.C.3.a(1) Effects from Routine Activities

IV.C.3.a(1)(a) Effects from Noise and Disturbance

Fishes inhabiting the arctic region (Figure III.B-2) are described in Section III.C.2. Arctic fish differ substantially from their counterparts inhabiting warmer regions. In addition to their many differences, arctic fish also have developed unique life history, behavioral, physiological, and population characteristics that enable them to exist under extremely harsh and fluctuating environmental conditions of both daily and seasonal occurrence. These conditions occasionally cause high mortalities, especially to the more sensitive lifestages (eggs and juveniles). Because of this, arctic fish populations have adapted to withstand at least short-term perturbations and fluctuations in the environment. This adaptive ability applies equally to both human- and naturally caused events.

Disturbance-related activities associated with OCS exploration and development include disturbances from pipeline construction; discharges from gravel mining and island construction and reshaping; noise from platform, island, or ice-road construction; and abandonment. Because the water used for construction purposes is not likely to be withdrawn from waters supporting fish, the use of freshwater for ice-road and pad construction is not likely to have a measurable effect on fish populations.

IV.C.3.a(1)(a)1) Disturbance from Pipeline Construction

Pipeline construction involves trenching, hydraulic dredging, backfilling material into the trench, and storing excess trenching material on the ice. These activities are likely to temporarily displace fish from the immediate area of the activities, and a few fish could be harmed or killed. However, these effects are not likely to continue after construction is completed or to have a measurable effect on fish populations.

IV.C.3.a(1)(a)2) Discharges from Gravel Mining and Island Construction and Reshaping

During construction, a few fishes in the immediate area of a discharge could be harmed or killed. However, most are likely to avoid these areas, and no measurable effects would be likely at the population level.

IV.C.3.a(1)(a)3) Noise from Platform, Island, or Ice-Road Construction

Noise from island construction and similar activities may affect fishes. Fishes sometimes avoid sudden noise but typically ignore the same noise, if it is continuous over a longer period of time (Bell, 1990). Fishes appear to respond to sound waves within the range of 5-1,000 Hertz (Bell, 1990). Because OCS activities are likely to generate noise within this range, some fishes in the immediate area may be temporarily disturbed. Because marine fish are widely dispersed and are largely unrestricted in their movements, noises associated with these activities likely would not have a measurable effect on marine fish populations.

Freshwater and migratory fishes, however, overwinter in fresh- or brackish water, where depths are sufficient to provide ample space and oxygen below the winter ice. Hence, overwintering fishes essentially are captives in these areas until spring breakup. Because they depend on overwintering habitats and are unable to move away from noise, the noise generated by construction-related activities may stress some overwintering fishes in the immediate area of the proposed activities and, thereby, decrease the likelihood of survival for some. However, noise effects on most overwintering fishes are likely to be short term and sublethal. For this reason and because most activities are not likely to occur above overwintering habitat, these activities are not likely to have a measurable effect on overwintering freshwater and migratory fish populations.

IV.C.3.a(1)(a)4) Effects of Small Onshore Oil Spills

Small onshore spills in summer would not have any effect on fishes, unless they occurred in or flowed into waters containing fish. If a small spill were to occur, some fish and food resources in the immediate area may be harmed or killed. However, due to the small amount of oil involved, the low diversity and abundance of fish in most of the onshore area, and the unlikelihood of spills blocking fish migrations or occurring in small waterbodies with restricted water exchange, small onshore oil spills are not likely to have a measurable effect on fish populations. A winter spill also likely would have no measurable effect on fishes, because the oil would spill on the ice above the waterways, would be cleaned up, and would not come in contact with fishes or their habitat.

IV.C.3.a(1)(a)5) Abandonment

Removing islands and undersea pipelines would increase the amount of suspended matter in the water, which could affect fishes. Typically, when the island's slope-protection materials are removed, waves, ice, and currents extensively erode its surface and, within a few years, the island is below sea level. If abandonment activities remove the concrete armor on the island's underwater slope, the amount of fish habitat and food resources would be reduced, which would reduce fish populations in the island area. Otherwise, none of these abandonment-related activities are likely to have a measurable effect on arctic fish populations.

Summary. Noise and discharges from dredging, gravel mining, island construction and reshaping, pipeline trenching, and abandonment are likely to have no measurable effect on fish populations (including incidental anadromous species). While a few fish could be harmed or killed, most in the immediate area would avoid these activities and would be otherwise unaffected. Effects on most overwintering fish are likely to be short term and sublethal, with no measurable effect on overwintering fish populations.

IV.C.3.a(2) Effects of a Large Oil Spill on Fish

The effects of oil spills on fish have been discussed in previous Beaufort Sea EIS's, including the Sale 144 Final EIS (USDOI, MMS, 1996a), which are incorporated here by reference and summarized. Oil spills have been observed to have a range of effects on fish (see Rice, Korn, and Karinen, 1981; Starr, Kuwada, and Trasky, 1981; Hamilton, Starr, and Trasky, 1979; and Malins, 1977 for more detailed discussions).

The specific effect depends on the concentration of petroleum present, the time of exposure, and the stage of fish development involved (eggs, larva, and juveniles are the most sensitive). If lethal concentrations are encountered, or sublethal concentrations are encountered over a long-enough period, fish mortality is likely to occur. However, mortality caused by a petroleum-related spill is seldom observed outside of the laboratory environment. Sublethal effects are more likely and include changes in growth, feeding, fecundity, and temporary displacement.

Other possibilities include interference with movements to feeding, overwintering, or spawning areas; localized reduction in food resources; and consumption of contaminated prey. Most acute-toxicity values (96-hour lethal concentration for 50% of test organisms [LC_{50}]) for fish generally are on the order of 1-10 parts per million. Concentrations observed under the oil slick of former oil spills at sea have been less than the acute values for fish and plankton. For example, concentrations observed 0.5-.0 meter beneath a slick from the *Tsesis* spill (Kineman, Elmgren, and Hansson, 1980) ranged from 50-60 parts per billion. Extensive sampling following the *Exxon Valdez* oil spill (about 260,000 barrels in size) also revealed that hydrocarbon levels were well below those known to be toxic or to cause sublethal effects in plankton (Neff, 1991).

The low concentration of hydrocarbons in the water column following even a large oil spill appears to be one of the main reasons for the lack of lethal effects on fish and plankton. Some of the studies following *the Exxon Valdez* oil spill (Michael et al., 1998; Marty et al., 1999) concerning the effects of that spill on fish populations in Prince William Sound were inconclusive. While adverse effects on some eggs and larva (pink salmon and herring) were likely to have occurred, natural perturbations cause extreme variation in these populations every year and preclude definitive conclusions. Other studies following the *Exxon Valdez* oil spill, conducted from 1989-1991 (Armstrong et al., 1995; Brannon et al., 1995; Pearson et al., 1999) were more conclusive. Regarding the effects of that oil spill on bottomfish and crustaceans, Armstrong et al. (1995) concluded:

> …we were not able to detect and document recurring and pervasive deleterious impacts at depth in PWS on the fauna of our study at either the individual or population levels, despite our best efforts to target species whose complete life cycle would cause persistent exposure in the water column, or on benthos through ontogenetic changes in location from larvae to juvenile to reproductive adult.

Regarding the effects of the *Exxon Valdez* oil spill on pink salmon, Brannon et al. (1995) stated:

> However, there was no apparent effect from oil exposure that would have a significant effect on the wild stock pink salmon population in the sound. Although negative indications of exposure to petroleum hydrocarbons have been reported in other studies related to the Exxon Valdez oil spill, neither results from the present early life-history studies nor the survival success of progeny of the 1988 and 1989 brood years would support such conclusions.

Regarding the effects of the *Exxon Valdez* oil spill on the collapse of the Pacific herring population in Prince William Sound that began in 1993, Pearson et al. (1999) stated:

> …we are convinced that a combination of increasing Prince William Sound herring biomass and decreasing food supply lead to poor condition of Prince William Sound herring, which resulted in the 1993 decline….

and

> The record high population levels and harvests of Prince William Sound herring in the years after the 1989 oil spill, the lack of change from the likely age class distribution, and the low level of oil exposure documented for herring in 1989 and the following years all indicate that the 1989 oil spill did not contribute to the 1993 decline.

Regarding the long-term effects of the *Exxon Valdez* spill on pink salmon fry, Rice et al. (2001) indicated that 4 years after the spill, the National Resource Damage Assessment researchers found elevated embryo mortality at streams that were oiled. Based on laboratory studies, National Resource Damage Assessment researchers hypothesized that this was due to exposure to polynuclear aromatic hydrocarbons in weathered oil, which were continuing to leach out of oiled streams. Industry researchers found no such evidence of instream oil or increased embryo mortality (Rice et al. 2001).

In summary, adverse effects on some fish eggs and juveniles (for example, pink salmon and herring) were likely to have occurred due to *the Exxon Valdez* oil spill, at least at the most heavily oiled sites. However, more than 10 years of study have revealed that the *Exxon Valdez* spill apparently had no measurable effect on any fish population, local or otherwise. Some still believe there were such effects and offer theories as to why they were never demonstrated. For example, Rice et al. (2001) states that effects of the *Exxon Valdez* oil spill could not be demonstrated at the stream population level (even at the most heavily oiled sites).

In 1985, this same researcher warned against making predictions concerning the effects of oil spills on fish populations based on laboratory studies alone, and suggested that laboratory results needed confirmation from field studies (due to conflicting laboratory results). Concerning the field studies conducted to that date (1985), he went on to state that even after the largest oil spills in history, the effects of those spills on fish populations were found to be negligible (Rice, 1985). Other researchers (for example, Pearson et al., 1999; Armstrong et al., 1995; Brannon et al., 1995; Maki et al., 1995) repeatedly have made similar conclusions concerning the effects of the *Exxon Valdez* oil spill on fish populations: that no population-level effects on fishes could be attributed to that oil spill. If measurable population-level effects were likely or even possible, they clearly would have been demonstrated by the largest spill in U.S. history, the *Exxon Valdez* oil spill. That oil spill occurred at a time of the year when it would have resulted in the maximum possible damage to fish populations. However, as can be seen from the oil-spill research conducted to date, population-level effects on fishes were not demonstrated, even in the worst-case situations. Hence, while adverse effects on some fish eggs and juveniles were likely to have occurred, measurable effects on fish populations (either local or regional) apparently did not occur. If any such effects did occur, they apparently have remained too small to observe or measure.

IV.C.3.a(2)(a) Offshore Oil Spill

From October through April, nearshore waters 6 feet or less in depth are frozen to the bottom, and marine fishes are widely dispersed seaward of the shorefast ice. Because of the barrier formed by this shorefast ice, and the fact that any oil trapped under floating ice would not disperse into the water, a winter offshore spill is not likely to have a measurable effect on marine fishes or on migratory fishes overwintering in the Sagavanirktok River Delta area. During the open-water period, the nearshore area of the Beaufort Sea is used for feeding and migratory purposes by marine and migratory fishes, including the areas of greatest species diversity, such as the Sagavanirktok River Delta. Hence, the unlikely occurrence of an offshore oil spill during the summer likely would have its greatest potential effect in the nearshore area.

In the unlikely event of an offshore oil spill occurring and contacting the nearshore area, some marine and migratory fish may be harmed or killed. However, lethal effects on fish from oil spills are seldom observed outside of the laboratory environment. For this reason, relatively small oil spills are likely to have mostly sublethal effects on the affected marine and migratory fish. Juvenile fish (for example, arctic cod), which are common in the nearshore area during summer, or nearshore spawners (for example, capelin) are among those most likely to be adversely affected. Some fish in the immediate area of a spill may be killed; however, it is not likely to have a measurable effect on marine and migratory fish populations. Recovery would be likely in 5-10 years. Oil-spill-cleanup activities are not likely to adversely affect fish populations. Small operational oil or fuel spills are not likely to contact fish habitat and, therefore, are not likely to affect fish.

IV.C.3.a(2)(b) Onshore Pipeline Oil Spill

Onshore bodies of freshwater are much smaller than the marine environment, where the effects of former oil spills have been observed. However, the amount of oil spilled onshore is likely to be much less than what might occur from an offshore spill. Additionally, an onshore pipeline spill would not affect fishes unless it entered freshwater habitat supporting fishes. In the unlikely event of an onshore oil spill contacting fish habitat, lethal effects are likely to be similar to those observed for oil spills at sea (very low). Sublethal effects are more likely to occur and would be similar to those discussed above. Some fish and food resources in the immediate area of an onshore oil spill may be harmed or killed, particularly if the spill occurred where and when fish were migrating, in overwintering areas during winter, or in small waterbodies having restricted water exchange.

Ninespine stickleback, arctic grayling, and Dolly Varden char have been found in the summer in the East Sagavanirktok Creek (Hemming, 1996). Ninespine sticklebacks move downstream and out of the creek in late summer as water temperatures drop. Dolly Varden char and arctic grayling may use the creek for summer rearing habitat (Hemming, 1996). Small runs of pink and chum salmon (anadromous species) sometimes occur in the Colville River, and in some of the drainages west of the Colville River; however, neither species has established populations anywhere on the North Slope (Bendock and Burr, 1984). In the unlikely event a pipeline oil spill occurred in winter, it likely would not affect fishes. However, if a summer spill of sufficient size occurred in a small waterbody containing fish with restricted water exchange, the fish and food resources in that waterbody likely would be harmed or killed. Recovery would be likely in 5-10 years. However, because of the small amount of oil from an onshore pipeline spill likely to enter freshwater habitat, the low diversity and abundance of fish in most of the onshore area, and the unlikelihood of spills blocking fish migrations or occurring in overwintering areas or small waterbodies (containing many fish or fish eggs) with restricted water exchange, there likely would be no measurable effect on fish populations. Oil-spill-cleanup activities are not likely to adversely affect fish populations.

IV.C.3.a(2)(c) Offshore Diesel Fuel Spill

Compared to a crude oil spill, a diesel spill would have a relatively short lifetime because of the high rates of dispersion and evaporation (USDOI, MMS, 1998). During winter, about 80% of the diesel fuel likely would evaporate and be dispersed by wave action within 30 days. During summer, all of the diesel likely would evaporate and be dispersed by wave action in only 7 days and likely would not reach shore.

In general, the effects of fuel spills on fish are likely to be similar to those of crude oil spills although much reduced in duration due to evaporation and dispersion. Hence, the likelihood of lethal effects likely would be even less than that observed for oil spills at sea. For this reason, a relatively small fuel spill is likely to have mostly sublethal effects on the marine and migratory fishes affected by it. Some fish in the immediate area of a spill might be harmed or killed; however, it is not likely to have a measurable effect on fish populations. Recovery of the number of fish harmed or killed would be likely within 5-10 years.

IV.C.3.a(2)(d) Oil-Spill Cleanup

Because of the low density of fish in the Beaufort Sea, and the low probability that they would be harmed by cleanup equipment, oil-spill-cleanup activities in open water or in broken ice are not likely to adversely affect fish populations. Reducing the amount of oil in the marine environment is likely to have a beneficial effect by reducing the possibility of hydrocarbons contacting fish and their food resources. The extent of that benefit would depend on the actual reduction in the amount of oil contacting fish and their food resources, as compared to that of not reducing the amount of contact.

Conclusion. Noise and discharges from dredging, gravel mining, island construction and reshaping, pipeline trenching, and abandonment are likely to have no measurable effect on fish populations (including incidental anadromous species). While a few fish could be harmed or killed, most in the immediate area would avoid these activities and would be otherwise unaffected. Effects on most overwintering fish are likely to be short term and sublethal, with no measurable effect on overwintering fish populations.

In the unlikely event of a large oil or diesel fuel spill, effects on arctic fishes (including incidental anadromous species) would depend primarily on the season and location of the spill; the lifestage of the fishes (adult, juvenile, larval, or egg); and the duration of the oil contact. Because of their very low numbers in the spill area, no measurable effects are likely on fishes in winter. Effects would be more likely to occur from an offshore oil spill moving into nearshore waters during summer, where fishes concentrate to feed and migrate. If an offshore spill did occur and contact the nearshore area, some marine and migratory fish may be harmed or killed. However, it likely would not have a measurable effect on fish populations, and recovery would be likely within 5-10 years. In general, the effects of fuel spills on fishes are likely to be less than those of crude oil spills.

In the unlikely event of an onshore pipeline oil spill contacting a small waterbody supporting fish (for example, ninespine stickleback, arctic grayling, and Dolly Varden char) and that had restricted water exchange, it likely would kill or harm most of the fish within the affected area. Recovery would be likely in 5-10 years. However, because of the small amount of oil or diesel fuel likely to enter freshwater habitat, the low diversity and abundance of fish in most of the onshore area, and the unlikelihood of spills blocking fish migrations or occurring in overwintering areas or small waterbodies (containing many fish or fish eggs), an onshore spill of this kind is not likely to have a measurable effect on fish populations on the Arctic Coastal Plain.

Effectiveness of Mitigating Measures. Stipulations 1-3, and ITL clause 11 are the mitigating measures most likely to have a beneficial effect on arctic fish populations. With these mitigating measures in place, there is an increased probability that (1) spawning and overwintering fish would be unaffected by activities associated with oil and gas activities, (2) fish passage and stream flows would be maintained, and (3) the effects of accidental fuel spills would be minimized. To the degree they are implemented, these mitigation measures are likely to benefit arctic fish populations. However, because oil and gas activities are likely to have no measurable effect on arctic fish populations, their absence is not likely to result in a measurable increase in adverse effects on arctic fish populations.

IV.C.3.b. Effects of Alternatives and Sales

Effects of Alternatives I and III through VI for Sales 186, 195, and 202. The activities associated with these alternatives would be essentially the same for Sales 186, 195, and 202. The volume of oil and the level of activities that could adversely affect fish remain essentially the same for all alternatives; hence, they would have the same level of effects as Alternative I. The deferral areas associated with these alternatives for each sale would eliminate disturbances to fish populations within the deferral area. Nevertheless, the overall amount of activity outside these deferral areas is likely to remain essentially the same for each sale, and the overall effects to the fish resources in the Beaufort Sea would be essentially the same for all alternatives for all three sales. Hence, any disturbances associated with Alternative I for Sales 186, 195, and 202 simply would occur somewhere outside of the deferral areas. However, the level of activity outside the deferral areas still would remain well below that likely to cause a measurable effect on any fish population. For this reason, and for the same reasons discussed at the beginning of this section, disturbances associated with Alternative I for Sales 186, 195, and 202 are not likely to have a measurable effect on fish populations.

Oil spills associated with Alternative I for Sales 186, 195, and 202 have various conditional probabilities of contacting nearshore Beaufort Sea habitat ranging from less than 0.5-21% (Table A.2-27). These probabilities do not vary for Sales 186, 195, and 202. Nearshore habitat is of greater concern when considering fish populations, because fish tend to concentrate there during the spring and summer to feed and move about. However, combined probabilities factor in the probability of a large oil spill actually occurring and the probability of it contacting specific target areas. Alternative I for Sales 186, 195, and 202 have a combined probability of less than 0.5%, which means that the chance of a spill actually occurring and then contacting any shoreline area is extremely low and the same for each sale. Even if that chance was very high, Alternative I for Sales 186, 195, and 202 assumes the same basic oil-spill parameters: (1) the size of the assumed offshore oil spill, (2) the amount and composition of the oil reaching the shore, (3) the amount and location of shoreline contacted, and (4) the amount of time the spilled oil would remain in the nearshore area. Variations in these parameters generate the primary differences in the estimated effect of any sale-related oil spill on fish populations. If an oil spill were likely to have a measurable effect, differences in these parameters would be necessary to estimate the magnitude of that effect. Because the parameters that would affect fish do not vary substantially between alternatives and Sales 186, 195, and 202, each of these alternatives and sales are likely to have essentially no measurable effect on fish populations.

Conclusion. Noise and discharges from dredging, gravel mining, island construction and reshaping, pipeline trenching, and abandonment are likely to have no measurable effect on fish populations (including incidental anadromous species). While a few fish could be harmed or killed, most in the immediate area would avoid these activities and would be otherwise unaffected. Effects on most overwintering fish are likely to be short term and sublethal, with no measurable effect on overwintering fish populations.

In the unlikely event of a large oil or diesel fuel spill, effects on arctic fishes (including incidental anadromous species) would depend primarily on the season and location of the spill; the lifestage of the fishes (adult, juvenile, larval, or egg); and the duration of the oil contact. Because of their very low numbers in the spill area, no measurable effects are likely on fishes in winter. Effects would be more likely to occur from an offshore oil spill moving into nearshore waters during summer, where fishes concentrate to feed and migrate. If an offshore spill did occur and contact the nearshore area, some marine and migratory fish may be harmed or killed. However, it likely would not have a measurable effect on fish populations, and recovery would be likely within 5-10 years. In general, the effects of fuel spills on fishes are likely to be less than those of crude oil spills.

In the unlikely event of an onshore pipeline oil spill contacting a small waterbody supporting fish (for example, ninespine stickleback, arctic grayling, and Dolly Varden char) and that had restricted water exchange, it likely would kill or harm most of the fish within the affected area. Recovery would be likely in 5-10 years. However, because of the small amount of oil or diesel fuel likely to enter freshwater habitat, the low diversity and abundance of fish in most of the onshore area, and the unlikelihood of spills blocking fish migrations or occurring in overwintering areas or small waterbodies (containing many fish or fish eggs), an onshore spill of this kind is not likely to have a measurable effect on fish populations on the Arctic Coastal Plain.

IV.C.4. Essential Fish Habitat

Analysis of essential fish habitat is required in environmental assessments as a result of The Sustainable Fisheries Act of 1997 and its enacting regulations. Regulations define essentially the whole of the Beaufort Sea to the limit of the 200-mile Exclusive Economic Zone as essential fish habitat for Pacific salmon. In this context, Pacific salmon comprises the five salmon species commonly known as pink or humpy (*Oncorchynchus gorbuscha*), chum or dog (*Oncorhynchus keta*), red or sockeye (*Oncorhynchus nerka*), silver or coho (*Oncorhynchus kisutch*) and king or chinook (*Oncorhynchus tshawutscha*).

By regulation, this section focuses in more detail on the potential as salmon habitat rather than on whether or not salmon presently use the habitat. The habitat includes not only the physical substrates and water-quality characteristics but also the salmon-prey foods and their habitats for all lifestages. These characteristics are more fully described in Section III.B.3 Affected Environment. The effects on salmon are evaluated in the general fisheries analysis of anadromous fish in Section IV.C.3. This section analyzes the remaining aspects of essential fish habitat.

IC.4.a. Effects Common to All Alternatives

The effects of development are common to all alternatives, but the same disturbances can have different effects on essential fish habitat in different regions within the Beaufort Sea.

IV.C.4.a(1) Introduction

A broad ecological look at the essential salmon habitat in the Beaufort Sea is the basis for defining the generic effects common to all alternatives. Dividing the Beaufort Sea into three areas and characterizing their differences from east to west is useful for understanding the effects of the various alternatives on salmon essential fish habitat. Map 13 illustrates the locations of these divisions along with the freshwater, estuarine, and marine salmon habitats. The total designated essential fish habitat to the limit of the Exclusive Economic Zone is shown on the inset map of Alaska to Map 13. Table III.B-1 summarizes the components, seasons, and areas of freshwater, estuarine, and marine essential fish habitats.

For purposes of analysis, the western Beaufort is from Barrow east to the Colville River Delta (see LA1-LA6 on Map 13). The central Beaufort encompasses most of the Colville River Delta and continues east to the Arctic National Wildlife Refuge (LA7-LA15 on Map 13). The eastern Beaufort continues from the western boundary of the Arctic National Wildlife Refuge east to the Alaska-Canada border (LA16-LA18 on Map 13).

The Beaufort Sea can be considered an ecological population sink for salmon rather than a source. It draws excess salmon from other areas rather than producing a surplus that colonizes new areas. The scarcity of documented salmon in the Beaufort Sea (see Section III.B.3) and the fact that the Beaufort Sea is at the northern boundary of the geographic distribution support this conclusion.

Within the Beaufort Sea itself, salmon have been documented in greater numbers and more often in the western than the eastern Beaufort. This reflects western locations being nearer the sources of the larger and more concentrated salmon populations in the Bering and Chukchi seas. The dominant ocean currents also tend to bring more nutrients to the western portion of the Beaufort Sea. Other physical differences such as temperature and salinity seem to differ little east to west. Overall, a given level of disturbance on essential fish habitat is likely to have a greater impact on the western Beaufort Sea than on the central or eastern Beaufort Sea.

IV.C.4.a(1)(a) Freshwater Habitat

As detailed in Section III.B.3, freshwater is most important for eggs and alevins from July through the winter and into May. The primary Beaufort Sea overwintering areas presently are the Colville and Sagavanirktok rivers in the central region. The Chipp River in the eastern region also may provide overwintering habitat (Fechhelm and Griffiths, 2001).

Effects on freshwater essential fish habitat potentially are greatest in the central Beaufort Sea. The central Beaufort provides the best freshwater (overwintering) habitat.

IV.C.4.a(1)(b) Estuarine Habitat

The largest variation in temperature and salinity that affects essential fish habitat is more directly a result of freshwater inputs rather than variation due to large-scale currents and ocean trends from east to west. Generally, freshwater inputs from large rivers will have a greater effect than overall east and west macro-effects. Primarily the large rivers, such as the Colville and Sagavanirktok rivers will have a warming and diluting effect on the nearshore. The warmer, less-saline waters from these rivers cause the 5-mile-wide estuarine belt that provides the juvenile salmon short-term rearing and migratory habitat as these salmon smolt move from freshwater, adapt to marine waters, and make their way to the Alaska Gyre. Salmon ride the gyre around the Gulf of Alaska until their time to return through this 5-mile-wide Beaufort Sea estuarine belt on their final spawning run. (The primary feeding and growth habitat for Pacific salmon, however, is recognized in the essential fish habitat literature to be south of the Beaufort Sea.)

Effects on estuarine habitats are likely to be greater in the western Beaufort Sea. Zooplankton is the primary prey of most salmon once they enter the estuarine habitat. The western and eastern Beaufort have greater zooplankton productivity than the central Beaufort. The eastern region has a pocket of particularly productive zooplankton habitat called the Boulder Patch, but it covers relatively small areas. Because salmon and baleen whales both favor the zooplankton copepod, the presence of bowhead whale-feeding areas in the eastern Beaufort indicates excellent marine feeding habitat for salmon. However, even if the eastern region has a higher zooplankton prey base, the western region is still more important, because all juvenile salmon have to transit the western Beaufort on their way to the Bering Sea.

IV.C.4.a(1)(c) Prey Habitat

Another portion of essential fish habitat is salmon prey and its habitat. Prey primarily is the zooplankton swimming in the open estuarine and marine waters. To a lesser extent, some benthic animals in the estuarine zone and on the shallow sea bottom along with smaller fish also compose part of the salmon prey base. (See Sections IV.C.1, IV.C.2, and IV.C.3 for effects on water quality, lower trophic-level organisms, and fishes for more detail.)

IV.C.4.a(1)(d) Marine Water Habitat

Effects in the marine habitat are similar to those in the estuarine habitat, because rearing salmon still depend on zooplankton resources.

It is useful to address the likelihood of Beaufort Sea marine waters ever actually becoming productive salmon habitat. The marine waters 320 kilometers north of the Beaufort coast formally are designated as essential salmon habitat. However, according to the preliminary assessment report for essential fish habitat (North Pacific Fisheries Management Council, 1997), this marine rearing stage historically does not involve the Beaufort Sea. Pink salmon occupy marine waters south of 60° N. latitude; coho south of 64° N. latitude; chinook in the Bering Sea 70° N. latitude and south; chum salmon south of the Bering Straight

(66° N. latitude), and sockeye in the larger Gulf of Alaska and the Pacific Rim. Temperature may explain most of this difference as the Beaufort Sea ranges around -2º Celsius in winter and -1º to +4º Celsius in summer (Okkonnen, 2002, pers. commun.) whereas coho salmon, for instance, prefer 12-15º Celsius (North Pacific Fisheries Management Council, 1997).

Over the entire Arctic Ocean, the annual trend in surface air temperature shows a warming of about 1.0 degrees Celsius per decade in the eastern Arctic primarily north of the Laptev and East Siberian seas. The western Arctic shows no trend or even a slight cooling in the Canadian Beaufort Sea (Rigor, Colony, and Martin, 2000). During fall, the trends show a cooling of about 1.0 degrees Celsius per decade over the Beaufort Sea and Alaska Sea (Rigor, Colony, and Martin, 2000). During spring, a significant warming trend of 2 degrees Celsius per decade can be seen over most of the Arctic. Summer shows no significant trend (Rigor, Colony, and Martin, 2000). Barrow has experienced a significant warming over the last 80 years, but this warming is not uniform for all seasons; neither is it uniform over the entire period from 1920-1980 (Lynch et al., 2001). It would be a warm day of global warming in the Beaufort Sea before salmon and grow to maturity in its marine waters. A temperature rise significant enough to create ecological effects bringing significant improvements to the presently very marginal habitat for salmon to rear and mature in the Beaufort Sea is unlikely over the next two decades. Sufficient warming for salmon, therefore, is unlikely to occur before expected production activity from these lease sales is completed in 2038.

In summary, the same type and size of disturbance (for example, seismic activity, turbidity from construction, or an oil spill) or size of deferral can be expected to have a slightly greater effect in the western Beaufort than in the eastern Beaufort. Less impact would be expected in the central region. One exception is that freshwater effects would be greatest in the central region.

IV.C.4.a(2) Effects of Exploration

IV.C.4.a(2)(a) Effects from Routine Activities

IV.C.4.a(2)(a)1) Seismic Surveys

Seismic waves will cause very short-term (less than 1 week in any one location) disturbances to essential fish habitat during exploration phases. Because the lease-sale blocks are beyond the estuarine habitat, seismic waves primarily will affect the marine habitat, especially during exploration, making it temporarily uninhabitable and displacing maturing fish. Hypothetically, there could be sublethal effects such as partial or temporary disruption of fish sensory organs (Hanna, 2002, pers. commun.) and effects to zooplankton. To our knowledge, however, the actuality of this possible sublethal effect has not been determined. Exploratory seismic testing likely would affect 162 square miles of habitat for 2-5 days. The effect would be spread out across the Beaufort Sea multiple-sale area and continue over 14 summers (about 630 open-water days) from 2004-2018. It likely would displace no more than three or four salmon, because salmon are expected to inhabit this area only after global warming significantly raises the Beaufort Sea temperature (see the discussion on global warming in Section I.C.1.e(3)). A temperature rise significant enough to cause ecological effects that would bring salmon to rear in the Beaufort Sea presumably would occur long after exploration is completed in 2018.

Seismic effects to zooplankton and zooplankton habitat would be of the same area and duration. The zooplankton would not be displaced but rather could have sublethal effects, from which they would recover within 1 week. If seismic waves do penetrate into the estuarine areas, zooplankton are expected to recover in 2 weeks. See Section IV.C.2 - Effects on Lower Trophic-Level Organisms for more detail. Effects on essential fish habitat from seismic exploration from the multiple sales are considered low.

IV.C.4.a(2)(a)2) Drilling-Mud Disposal

Short-term (less than 3 years) effects are expected from drilling-mud disposal. Drilling-mud disposal will not affect the major prey, zooplankton, or fish or their habitats. Drilling muds are expected to affect a minor prey, benthic organisms, at sublethal levels (and their benthic habitat) within 1,000 meters of the 34 exploratory wells or a total of 2,700 acres (approximately 2,000 hectares) per year. Benthic prey and habitat would recover from sublethal effects within 3 years. Effects on essential fish habitat from drilling-mud disposal are considered low.

IV.C.4.a(2)(a)3) Turbidity

Turbidity would be caused by gravel dumping during construction of up to three gravel islands during the development phase. Sediments would remain suspended for 2-3 hours but would not extend farther than 3 kilometers from the dumping site. Gravel dumping for island construction is estimated to take 45 days, and turbidity effects would last a few days beyond the dumping. Turbidity would range over 168 square kilometers of salmon and salmon prey habitat. See Section IV.C.1 - Effects on Water Quality for more details.

Disturbances to the water column (prey, prey habitat, and salmon habitat) in the form of increased turbidity from drilling muds are limited to 266 acres (108 hectares) of marine habitat around drilling operations. Water quality is expected to be slightly toxic to nontoxic inside of a 100-meter (328-foot) radius, or 0.03 square kilometer (7 acres) around each drilling discharge site as a result of those discharges. See Section IV.C.1 for a more detailed discussion of the effects on water quality. Effects to essential fish habitat from turbidity caused by gravel dumping are considered low.

Summary. The disturbance effects during the exploratory phase are all limited to the 45-day open-water season, except for the possible 3-year recovery of benthic prey and their habitat around exploratory wells. However, benthic organisms are only a minor prey item.

IV.C.4.a(2)(b) Effects from Very Large and Very Unlikely Oil Spill

The effects of a very unlikely very large oil spill are evaluated in Section IV.I.2.d.

IV.C.4.a(3) Effects of Development and Production

IV.C.4.a(3)(a) Effects from Routine Operations

Effects on essential fish habitat from seismic surveys, drilling-mud disposal, and ice-road construction in the development phase generally would be similar in type but somewhat higher in volume than from the exploration phase. The construction and operation of offshore pipelines and the potential for oil spills, however, are a much greater threat to essential fish habitat during the development phase.

IV.C.4.a(3)(a)1) Seismic Surveys

Seismic effects during development would be similar in type, but they would take place over twice the area and for a longer duration. Seismic surveys in the development phase would affect the not only the marine habitat but also the estuarine habitat because of seismic surveys conducted for under sea pipelines from platforms to landfall. Possible sublethal effects have been hypothesized but not scientifically proven or disproven. Effects on essential fish habitat from seismic surveys conducted for the multiple sales are considered low.

IV.C.4.a(3)(a)2) Drilling-Mud Disposal

Volumes of drilling muds likely would be 13 times greater than during the exploratory phase, 292,000 short tons. The area affected would be about 12 times greater, because 314 production wells are likely compared to 36 exploratory wells. Effects on essential fish habitat from the disposal of drilling muds are considered low during the development phase.

IV.C.4.a(3)(a)3) Turbidity

Turbidity would result from dumping gravel to construct two or three gravel islands. Sediments would remain suspended for 2-3 hours, but they would not extend farther than 3 kilometers from the dumping site. Gravel dumping for island construction is estimated to take 45 days, and the effects would last a few days beyond the actual gravel dumping. Turbidity would range over 57-84 square kilometers of salmon and salmon prey habitat. See Section IV.C.1 - Effects on Water Quality for more details. Effects from turbidity on essential fish habitat are considered low.

IV.C.4.a(3)(a)4) *Offshore Pipeline Construction and Operation*

Turbidity effects on essential fish habitat from offshore pipeline construction would be similar to disturbance from dredging for constructing gravel islands. Dredging operations show that there is a decrease in the concentration of suspended sediments within a short time (2-3 hours) and distance (a few hundred meters to a few kilometers) downcurrent from the dredging operations (USDOI, MMS, 2001b:Section III.C.3.l). If construction of a 65-kilometer long pipeline creates a 2-kilometer wide plume on either side during the construction season, a 258 square kilometer area could be affected, which is three to five times the area affected by the construction of a gravel island. Effects on essential fish habitat from turbidity created from the construction of an offshore pipeline are considered low.

IV.C.4.a(3)(a)5) *Onshore Pipeline Construction and Operation*

Because of their relatively small size, new offshore projects will use the existing infrastructure wherever possible. Therefore, no increased effects on essential fish habitat are expected.

IV.C.4.a(3)(a)6) *Ice-Road Construction*

Ice roads and ice pads would be constructed for the offshore development phase. For the proposed Liberty development, an estimated 120 million gallons of freshwater could be needed annually during the construction phase and 20 million gallons annually thereafter for the construction of ice roads and ice pads (USDOI, MMS, Alaska OCS Region, 2002a).

Winter water withdrawals are prohibited from rivers and streams or shallow lakes (less than 7 feet deep) interconnected with or flooded by fish-bearing streams (USDOI, Bureau of Land Management and MMS, 1998). However, regulations allow withdrawal of up to 15% of the free-water volume from deeper, potential overwintering lakes, including those connected to river systems and available to anadromous fish.

Generally, winter water drawdown from "lakes 7 feet (2.1 meters) deep or deeper shall be limited to 15% of the estimated free-water volume (i.e., excluding the ice)." Regulators may authorize greater than 15% drawdown, if the proponent demonstrates that no fish exist in the lake. "Operators are encouraged to use new ice-road and ice-pad construction methods, such as using aggregate chips shaved from frozen lakes, to decrease water demands, construction time and impact on fisheries" (USDOI, Bureau of Land Management and MMS, 1998)

Deepwater habitat suitable for wintering fishes is a limiting factor that controls fish-species richness and the relative abundance of fish found on the North Slope (Hemming and Ott, 1994).

Despite the critical importance to survival, very little knowledge exists on actual overwintering habitat of Beaufort Sea anadromous fish. Overwintering habitat is a more-severe habitat constraint, because it is essential, scarce, isolated, and necessary for two-thirds of the year (Craig, 1989). In the Beaufort Sea, anadromous fish survive by retreating to essential overwintering habitat as the vast food-rich coastal marine summer habitat becomes frigid and inhospitable in fall. Just when the roughly equal-sized inland waters become essential for overwintering they become a scarce resource, shrinking by 98%. Even the Colville and Sagavanirktok, the two largest rivers on the North Slope, cease flowing by late winter and freeze to the bottom over long stretches (Arnborg et al., 1966). As fish crowd into limited deepwater pockets, the waters become overcrowded, anoxic, and subject to freezing. Once the connecting channels freeze solid, the fish are isolated and cannot move to better habitat. Fish must survive a minimum of 8 months a year in this limiting overwinter habitat, from fall freezeup to spring breakup, so they can return to the nourishing, food-rich coastal environments for their short 1.5- to 2.5-month summer-growth spurt. Human activities or water withdrawals can be fatal to fish during this particularly vulnerable overwintering period.

We have little knowledge of the location, characteristics, and variation of overwintering sites and few regulatory protections for this critical habitat. State of Alaska regulations limit freshwater removals to15% of any freshwater habitat in lakes greater than 2 meters deep (i.e., potential overwintering sites). If even 15% of the water in an overwintering site is used for ice roads to offshore development, it potentially could reduce survival by a much higher percentage. Therefore, the effects of ice-road construction for the multiple sales on freshwater essential fish habitat could range from low to moderate because of the uncertainty of the effects of withdrawing up to 15% of the free water during winter.

IV.C.4.a(3)(b) Effects of a Large Oil Spill

IV.C.4.a(3)(b)1) Effects on Freshwater Habitat

Oil spills probably pose the greatest risk to essential fish habitat. A recent survey of remaining North Slope Alaska crude oil from the *Exxon Valdez* oil spill in Prince William Sound found unexpectedly high levels of oil with little weathering, even after 10 years (Short, 2002, pers. commun.). Modeling on this broad Beaufort wide scale indicates that in the unlikely event that an oil spill greater than or equal to 1,000 barrels occurs, there is less than a 5% chance of freshwater resources being contacted within 10 days. However, 360-day oil movements are a more accurate predictor of which parts of the essential fish habitat may be contaminated by oil. Oil spilled during the ice season would freeze into the grease ice and slush ice. The pools on the ice surface would concentrate the oil but would allow 5% evaporation of the lighter, more toxic components of the crude oil. In late spring and summer, the unweathered oil pools would drain into the water. Evaluating the oil location after 360 days makes the small differences between alternatives more apparent.

The majority of the coastal regions have a 1-2% chance of being contacted, should a large oil spill occur. The greatest likelihood of spilled oil contacting the coastal freshwaters is a 3-14% chance near the western half of the National Petroleum Reserve in Alaska in the western Beaufort Sea. The second most-likely section of freshwater to be contacted is the Kaktovik/Barter Island vicinity in the eastern Beaufort Sea, a 2-10% chance. This eastern Beaufort coastline, though relatively shorter than the central and western Beaufort coastlines, is more densely populated with anadromous streams. While this eastern coastal region is short and adjacent to fewer potential lease blocks, it is more densely populated with anadromous streams containing potential spawning and overwintering areas. There is an intermediate chance (1-7%) of oil spills contacting freshwater habitat in the Colville River, Canning River, and Kuparuk/Simpson Lagoon/Oliktok Point coastal areas.

IV.C.4.a(3)(b)2) Effects on Estuarine Habitat

The 5-mile-wide band of estuary habitat along the coast is at a similar but slightly higher risk of being oiled as the freshwater habitat. Among the three habitat types (freshwater, estuary, marine waters), effects are most likely to be in the very shallow estuarine zone very close to shore where outmigrating salmon are at their most fragile lifestage as, all at once, they change their physiological regulatory mechanisms from fresh- to saltwater. Their osmoregulatory systems must make the transition from actively drawing salts into their cells in freshwater to actively pushing salts out across their semipermeable cell-wall membranes in saltwater. At the same time, they are entering this new more dangerous habitat and must, within a few days, feed on the new prey species to survive.

Because the new salmon smolt occupy the shallowest waters, for example, only a few centimeters deep for pink salmon (North Pacific Fisheries Management Council, 1997), surface oil is more likely to be deposited in the shallow substrate, and salmon prey are more likely to be oiled. The salmon smolt also are more likely to be oiled. They are unlikely to be able to effectively avoid oil washing the shore and this immediately adjacent very shallow estuarine habitat in the short term. One year of salmon smolt could be affected, and salmon populations would expect to recover within one generation.

There would be no intertidal effect on pink salmon spawning and resultant genetic effects as occurred in Prince William Sound, because the intertidal range in the Beaufort Sea multiple-sale area is only 10-20 centimeters.

IV.C.4a(3)(b)3) Effects on Marine Habitat

The marine areas have the greatest likelihood of being oiled, both immediately and longer term. The probability increases from the west to the east. In the unlikely event that a spill greater than or equal to 1,000 barrels of oil occurs, the eastern region has the greatest chance, up to a 59% chance of being contacted within 10 days and a 65% chance within a year. In most cases, salmon would recover within one generation. One year of maturing salmon would be affected, and salmon populations would expect to recover.

Conclusion. The same type and size of disturbance (for example, seismic activity, turbidity from construction, or an oil spill) or size of deferral can be expected to have a slightly greater effect in the western Beaufort than in the eastern Beaufort. Less impact would be expected in the central region. One exception is that freshwater effects would be greatest in the central region.

Disturbance effects during the exploratory phase are limited to the 45-day open-water season, except for the possible 3-year recovery of benthic prey and their habitat around exploratory wells. However, benthic organisms are only a minor prey item.

Effects on essential fish habitat from seismic surveys, drilling-mud disposal, turbidity, and pipeline construction (both offshore and onshore) are considered low. The effects of ice-road construction could range from low to moderate because of the uncertainty of withdrawing up to 15% of the free water from lakes during the winter. In most cases, the salmon would recover within one generation.

In the unlikely event that a large oil spill occurs, effects on freshwater essential fish habitat would be low. Effects on estuarine and marine essential fish habitats could be moderate because, in most cases, salmon would recover within one generation. Effects on marine and estuarine essential fish habitats could be considered moderate because, in most cases, salmon would recover within one generation. Changes in abundance would be limited to a population or portion of a population (populations in one stream or in even or odd years for pink salmon populations) and/or for a short time period.

IV.C.4.b. Effects of Alternatives and Sales

IV.C.4.b(1) Effects of Alternative I for Sale 186

The effects of disturbances and discharges are the same for all alternatives and sales, because the level activities that would affect disturbances for essential fish habitat is the about the same for all alternatives and sales.

The immediate effects (within 10 days) of an oil spill likely would be highest in the Kaktovik/Barter Island area in the eastern Beaufort Sea and the National Petroleum Reserve-Alaska in the western Beaufort Sea. The areas with the greatest likelihood of being contacted within 1 year of a general spill are near the eastern Petroleum Reserve, the Colville River, and the Barter Island/Kaktovik areas.

Within 10 days of a pipeline spill, oil most likely would contact the eastern Petroleum Reserve, Oliktok Point (east of Colville River); the next most likely place is the Kaktovik/Barter Island areas. Within 1 year of a pipeline spill, the Colville River and Oliktok Point are most likely to be contacted by oil; the eastern Petroleum Reserve and the area west of the Colville River are slightly less likely to be contacted.

Conclusion. The effects of an oil spill on salmon essential fish habitat would be considered moderate because, in most cases, salmon and salmon habitat would recover within 1 generation. One year of salmon smolt would be affected, and salmon populations would expect to recover. Effects from disturbances and seismic activity in both the exploratory and development stages on freshwater and marine essential fish habitats would be low. Changes in abundance are limited to a population or portion of a populations (one stream, or in even or odd years for pink salmon) and/or for a short time period.

IV.C.4.b(2) Effects of Alternatives III through VI for Sale 186

Under sale 186, the alternatives are ranked based on the effects of an equal level of disturbance.

Table IV.B-1 gives a rank ordering of alternatives given equal disturbance. A ranking of 1 means that deferral mitigates the most potential impacts of development in the Beaufort Sea. These ranks are based on a composite of the following analysis of the freshwater, estuarine, and marine habitats.

In freshwater, the central region has by far the greatest potential for spawning and juvenile rearing. The central region has 78% of the potential freshwater habitat downstream of pipelines and roads.

For estuarine habitat, the east, central, and western Beaufort Sea areas are very similar, each between one-quarter and one-third of the total. The maximum difference in estuarine habitat value between the eastern, central, and western regions is 12%. The western Beaufort is most valuable in terms of potential salmon habitat, because it is closest to source populations, and all salmon transit on their way to and from the Pacific Ocean. Zooplankton are more productive here than in the central Beaufort. Marine essential fish habitat is largest in volume and most susceptible to oil spills compared to freshwater and estuarine habitats; however, largely because of cold temperatures it has the least realistic long-range potential to actually support salmon. The central Beaufort has 53% of the marine area. The eastern Beaufort has the least marine area (17%) and is the farthest from source populations.

Conclusion. The effects of an oil spill on salmon essential fish habitat would be considered moderate because, in most cases, salmon and salmon habitat would recover within 1 generation. One year of salmon smolt would be affected, and salmon populations would expect to recover. Effects from disturbances and seismic activity in both the exploratory and development stages on freshwater and marine essential fish habitats would be low. Changes in abundance are limited to a population or portion of a populations (one stream, or in even or odd years for pink salmon) and/or for a short time period.

IV.C.4.b(3) Effects of Alternatives I and III through VI, for Sale 195

Effects of seismic noise, drilling-mud discharges, offshore pipelines, and onshore pipelines and platforms essentially would be the same as above for Alternative I for Sale 186, because similar levels of exploration and development are expected. The expected difference in effects on essential fish habitat is due to changing technology, increasing knowledge of essential fish habitat, and changes in environment regulations. The changes from starting and ending development 3 years later, 2007-2039 versus 2004-2036, could reduce the effects of Sale 195 by approximately 5%, were the locations exactly the same. However, because the same blocks will be offered in each sale, the blocks that are closest to the central Beaufort Sea area would be leased in 2003 from Sale 186. Blocks that are more difficult to develop would be leased in Sales 195 and 202.

The ranking of effects of the alternatives will be the same as in Sale 186 (see Table IV.B-1).

Conclusion: The effects of an oil spill would be considered slightly higher than for Sale 186 but still moderate because, in most cases, salmon likely would recover within one generation. One year of salmon smolt would be affected, and salmon populations would expect to recover. Effects from disturbances and seismic activity in both the exploratory and development stages on freshwater and marine would be low, i.e., changes in abundance are limited to a population or portion of a populations (one stream, or in even or odd years for pink salmon) and/or for a short time period.

IV.C.4.c. Effects of Alternatives I and III through VI for Sale 202

Turbidity generated by building gravel islands for platforms will decrease by 33%, because two platforms instead of three are expected and only one platform will be in water shallow enough for an artificial gravel island. All of the other effects of exploration and development would be similar to those of the other alternatives and sales, because similar levels of exploration and development are expected.

The ranking of effects of the alternatives will be the same as in Sale 186 (see Table IV.B-1).

Conclusion: The effects of an oil spill would be considered higher than in Sales 186 and 195 but still moderate, because in most cases salmon would recover within one generation. One year of salmon smolt would be affected and salmon populations likely would recover. Effects from disturbances and seismic activity in both the exploratory and development stages on freshwater and marine would be low, i.e., changes in abundance are limited to a population or portion of a populations (one stream, or in even or odd years for pink salmon) and/or for a short time period.

IV.C.5. Endangered and Threatened Species

The endangered bowhead whale and the threatened spectacled eider and Steller's eider may occur seasonally in the Beaufort Sea Planning Area and may be exposed to OCS exploration and development/production activities associated with Alternative I for Sales 186, 195, 202. The OCS activities under the Alternative I for Sales 186, 195, and 202 and the development of any resources may result in noise and disturbance, altered habitat, and spilled oil or other contaminants, such as discharges of drilling muds and cuttings, which could adversely affect the behavior, distribution, and abundance of individuals or populations occurring in or adjacent to the Beaufort Sea multiple-sale area. It is assumed that crude oil would not be released during exploration.

Pursuant to requirements under the Endangered Species Act of 1973, as amended, the MMS Alaska OCS Region has consulted with the Fish and Wildlife Service and National Marine Fisheries Service on several previous lease sales in this region (most recently, Beaufort Sea Planning Area Oil and Gas Lease Sales 144 and 170). In both the Sale 144 and the Sale 170 Biological Opinions, the Fish and Wildlife Service concluded that the lease sales and associated activities would not be likely to jeopardize the continued existence of the spectacled eider or the Steller's eider. The National Marine Fisheries Service stated that the implications of these sales and previous sales in the Beaufort Sea were considered in the 1988 Arctic Regional Biological Opinion. The National Marine Fisheries Service stated that conclusions and recommendations contained in the 1988 Arctic Regional Biological Opinion were applicable to Sale 144 and Sale 170 and concluded that leasing and exploration activities were not likely to jeopardize the continued existence of endangered whales. Consultation on the Arctic Regional Biological Opinion was reinitiated because of new information on the effects of noise on bowhead whales from OCS activities and new technology for seismic operations. A revised Biological Opinion for Oil and Gas Leasing and Exploration Activities in the Beaufort Sea was issued in 2001. The 2001 Biological Opinion also concludes that oil and gas leasing and exploration in the Beaufort Sea is not likely to jeopardize the continued existence of bowhead whales.

In accordance with the Endangered Species Act Section 7, regulations governing interagency cooperation, MMS notified the Fish and Wildlife Service and the National Marine Fisheries Service by letter dated January 7, 2002, of the endangered and threatened species that would be included in a Biological Evaluation for section 7 consultation. The National Marine Fisheries Service responded on February 11, 2002, confirming the bowhead whale as the species under their jurisdiction to be included in the evaluation. They also indicated that separate consultations are underway or will be initiated regarding the effects of the Trans-Alaska Pipeline System and the marine transport of oil from the terminal at Valdez. They confirmed that MMS did not need to consult on listed species and critical habitat along the pipeline or out of Valdez. The MMS reinitiated formal consultation with the National Marine Fisheries Service for oil and gas leasing and exploration in 2000 and received the Beaufort Sea Biological Opinion from them in 2001. The National Marine Fisheries Service concluded that leasing and exploration are not likely to jeopardize the continued existence of the bowhead whale.

The Fish and Wildlife Service responded on February 11, 2002, and confirmed spectacled and Steller's eiders as the appropriate species under their jurisdiction to be discussed in the evaluation. They also confirmed that MMS did not need to evaluate the effects of transporting oil from Valdez to ports along the Pacific coast and the Far East, indicating this issue will be addressed in a separate consultation with the U.S. Coast Guard.

The draft EIS was completed and, in accordance with Section 7(a) of the Endangered Species Act, formal consultation on the proposed Beaufort Sea multiple-sale program, including leasing and exploration activities associated with the sales, was initiated with NOAA Fisheries and the Fish and Wildlife Service by letter dated May 9, 2002. The draft EIS served as the biological evaluation for the proposed action. The MMS plans to prepare an Environmental Assessment for subsequent sales (Sales 195 and 202) under the multiple-sale program and submit the Environmental Assessment to NOAA Fisheries and the Fish and Wildlife Service as part of the consultation process. Based on information contained in the Environmental Assessment, the MMS will reinitiate consultation if there is new information that would trigger the need to reinitiate consultation. The MMS requested that the NOAA Fisheries uphold the May 2001 Beaufort Sea Biological Opinion for the Beaufort Sea multiple-sale program. The NOAA Fisheries responded by letter dated July 23, 2002, that the May 2001 opinion addresses listed species and anticipated actions under the multiple-sale program, and that Section 7 consultation requirements have been met for Sale 186. The applicability of the May 2001 opinion will be reconsidered prior to the subsequent sales, based on information submitted in the Environmental Assessments prepared for those sales. The Fish and Wildlife Service responded with a Biological Opinion dated October 22, 2002. The Service determined that it is unlikely that the entire action, including eventual development and production, will violate Section 7(a)(2) of the Endangered Species Act. However, development and production activities would require separate consultations. The Fish and Wildlife Service biological opinion contained a reasonable and prudent measure that they and the MMS cooperatively develop a lighting protocol to minimize the likelihood of migrating spectacled or Steller's eiders striking exploration or delineation structures. Appendix C contains copies of the consultation communications.

The analysis contained in this section is based on an exploration and development scenario presented in Section IV.A.1 and Appendices B and F of this EIS. The reader is referred to these sections for a discussion of resource-recovery rates and quantities, timing of infrastructure development, platform emplacement, wells drilled, and resource production timeframes and other information relevant to the development of the resources of Alternative I for Sales 186, 195, and 202. Differences in effects to the species as a result of noise and disturbance over this range of scenarios likely would be minor. Differences in effects to the species as a result of an oil spill during the development/production scenario (million-barrel-resource range) also likely would be minor.

IV.C.5.a. Bowhead Whales

IV.C.5.a(1) Effects Common to All Alternatives

IV.C.5.a(1)(a) Effects of Noise and Disturbance on Bowhead Whales

There is concern that manmade noise affects bowheads by raising background noise levels. Increased noise levels could interfere with communication among bowheads, mask important natural sound, cause physiological damage, or alter normal behavior, such as displacing a migration route farther from shore.

Sound is transmitted efficiently through water. Hydrophones often detect underwater sounds created by ships and other human activities many kilometers away, far beyond the distances where human activities are detectable by senses other than hearing. Sound transmission from noise-producing sources is affected by a variety of factors, including water depth, salinity, temperature, sound frequencies, ice cover, bottom type, and bottom contour. In general terms, sound travels farther in deep water than it does in shallow water. Sound transmission in shallow water is highly variable, because it is strongly influenced by the acoustic properties of the bottom material, bottom roughness, surface conditions, and ice cover. Smooth, annual ice cover may enhance sound propagation as compared to open-water conditions. However, as ice cracks and roughness increases, sound transmission generally becomes poorer than in open water of equivalent depth. At this point, the roughness of the under-ice surface becomes more significant in influencing sound-transmission loss than bottom properties (Richardson and Malme, 1993).

Marine mammals use calls to communicate and probably listen to natural sounds to obtain information important for detecting open water, navigating, and avoiding predators. Baleen whale hearing has not been studied directly. There are no specific data on sensitivity, frequency or intensity discrimination, or localization (Richardson et al., 1995a). For each species, the frequency range of reasonably acute hearing in baleen whales likely includes the frequency range of their calls. Most baleen whale sounds are concentrated at frequencies less than 1 kilohertz, but the frequency range in bowhead songs can approach 4,000 Hertz (Richardson et al., 1995a). Most calls emitted by bowheads are in the frequency range of 50-400 Hertz, with a few extending to 1,200 Hertz. Based on indirect evidence, at least some baleen whales are quite sensitive to frequencies below 1 kilohertz but can hear sounds up to a considerably higher but unknown frequency. Most of the manmade sounds that elicited reactions by baleen whales were at frequencies below 1 kilohertz (Richardson et al., 1995a). Some or all baleen whales may hear infrasounds, sounds at frequencies well below those detectable by humans. Even if the range of sensitive hearing does not extend below 20-50 Hertz, whales may hear strong infrasounds at considerably lower frequencies. Based on work with other marine mammals, if hearing sensitivity is good at 50 Hertz, strong infrasounds at 5 Hertz might be detected (Richardson et al., 1995a).

There is speculation that under some conditions, extremely loud noise might cause temporary or permanent hearing impairment of bowheads, as occurs in terrestrial mammals under some conditions (Kryter, 1985). Exposure of mammals to strong noise, even for a brief period, causes a temporary elevation of the hearing threshold called a temporary threshold shift (Kryter, 1985, as cited in Richardson and Malme, 1993). If a temporary threshold shift occurs in bowheads, it could have a negative effect on their ability to hear calls and other natural sounds. In humans, prolonged exposure to intense noise or brief exposure to shock waves can cause permanent threshold shift. According to Richardson and Malme (1993), there is no evidence that noise from routine human activities (aside from explosions) would permanently cause negative effects to a marine mammal's ability to hear calls and other natural sounds. Given their mobility and avoidance reactions, it is unlikely that whales would remain close to a noise source for long. Also, baleen whales themselves often emit calls with source levels near 170-180 decibels re 1 microPascal (dB re 1µPa) comparable to those from many industrial operations. It is unknown whether noise pulses from non-explosive seismic sources, which can have source levels much higher than 170-180 decibel, are physically injurious at any distance. These devices were adopted, in part, because they cause little damage to fish, even at distances within a few meters (Richardson and Malme, 1993). Airguns are also safer for human operators. Airguns can be tuned in arrays and fired more frequently, advantages not available with explosives. The avoidance reactions of bowheads to approaching seismic vessels normally would prevent exposure to potentially injurious noise pulses (Richardson and Malme, 1993).

The zone of audibility is the area within which a marine mammal can hear the noise. The ability of a mammal to hear the sound, such as from seismic operations, depends on its hearing threshold in the relevant frequency band and the level of ambient noise in that band. The radius of the zone of audibility also depends upon the effective source level of the sonic pulse for horizontal propagation and on the propagation loss between the source and the potential receiver. The zone of responsiveness around a noise source is the area within which the animal would react to the noise. This zone generally is much smaller than the zone of audibility. The distance at which reactions to a particular noise become evident varies widely, even for a given species. A small percentage of the animals may react at a long distance, the majority may not react unless the noise source is closer, and a small percentage may not react until the noise source is even closer still. The activity of a whale seems to affect how a whale will react. In baleen whales, single whales that were resting quietly seemed more likely to be disturbed by human activities than were groups of whales engaged in active feeding, social interactions, or mating (Richardson et al., 1995a). Habitat or physical environment of the animal also can be important. Bowhead whales whose movements are partly restricted by shallow water or a shoreline sometimes seem more responsive to noise (Richardson et al., 1995a).

Noise-producing exploration activities, including geophysical seismic surveys, drilling, aircraft traffic, icebreaking or other vessel traffic, and construction are the activities most likely to affect bowhead whales.

IV.C.5.a(1)(a)1) Effects from Seismic Operations

Sound from seismic exploration is a potential source of noise disturbance to bowhead whales. Marine seismic exploration uses underwater sounds with source levels exceeding those of other activities discussed here. Marine seismic operations use high-energy airguns to produce a burst of underwater sound from the release of compressed air, which forms a bubble that rapidly expands and then contracts. Although the output of airgun arrays usually is tuned to concentrate low-frequency energy, the impulsive nature of the bubble collapse inevitably results in a broadband sound characteristic, and high-frequency energy also is produced. This means animals sensitive to either low-frequency or high-frequency sounds may be affected. Airgun arrays are designed to focus the sound energy downward. Despite this, sound pulses also are projected horizontally. Airgun arrays produce short-duration (transient) noise pulses with very high peak levels. The high peak level and impulsive nature of airguns have caused concern in the environmental community.

Marine seismic programs can be either 2- or 3-dimensional seismic surveys. A 2-dimensional seismic survey typically is more regional in nature and seismic lines tend to be much further apart (rarely closer than 1 kilometer) than in 3-dimensional surveys. Seismic programs generally use 2-dimensional seismic to explore large areas relatively inexpensively with the intent of identifying areas that warrant further exploration, such as drilling an exploration well or acquiring a 3-dimensional seismic survey. Seismic lines often are laid out in a number of different directions. Information that can be extracted from 2-dimensional seismic data is much more limited than information from 3-dimensional seismic data. Marine surveys in the Beaufort Sea OCS waters in the 1980s and most of the 1990s were 2-dimensional seismic. Ocean-bottom cable surveys in recent years have been 3-dimensional seismic. A 3-dimensional seismic survey is conducted on a closer grid and provides more detailed information about the subsurface. The more detailed data allow geoscientists to make realistic estimates of the amount and distribution of hydrocarbons within a reservoir.

Seismic surveys are of two types: (1) the high-resolution, shallow-seismic survey and (2) the low-resolution, deep-seismic survey. The next few paragraphs provide a brief discussion of a number of studies on the effects of noise from seismic operations on bowhead whales.

IV.C.5.a(1)(a)1)a) High-Resolution Seismic Surveys

These surveys, which are of much lower energy, generally are conducted on leases following a lease sale to evaluate potential shallow hazards to drilling. Equipment used to conduct high-resolution seismic surveys/shallow-hazard seismic surveys include side-scan sonar, sub-bottom profiler, boomers, sparkers, gas exploders, waterguns, airguns, etc. The energy level of many of these is from one to three orders of magnitude less than for some of the equipment used in deep-seismic surveys. For example, a 2000-cubic-inch airgun array used in deep-seismic surveys has approximately $2x10^6$ foot-pounds of energy compared to an 80-cubic-inch airgun that likely would be the largest used in high-resolution seismic surveys and has approximately $9x10^4$ foot-pounds of energy. Airguns used in high-resolution seismic surveys generally would be no larger than 40-cubic inches, although an 80-cubic-inch airgun rarely might be used in some circumstances. Boomers, sparkers, and gas exploders range from about $8x10^2$-$9x10^4$ foot-pounds of energy. The majority of equipment used in these surveys has less than $5x10^3$ foot-pounds of energy. For additional comparison, the 2,000-cubic-inch airgun has an energy equivalent of slightly more than 1 pound of 60% dynamite at the 30-foot depth, while the 80-cubic-inch airgun has an energy equivalent of .06 pound of 60% dynamite at the 30-foot depth (Telford et al., 1978).

Some high-resolution seismic surveys, such as those using airguns, emit loud sounds; but the sounds would not be as loud as sounds from deep-seismic surveys. The sound also would not be likely to propagate as great a distance as sounds from deep seismic surveys. Shallow-hazard seismic surveys for exploration- or delineation-well sites most likely would be conducted during the ice-free season. Because high-resolution seismic surveys are of lower energy and sound would be less likely to travel as far as sound from deep-seismic surveys, these activities are less likely to have significant effects on endangered whales. Bowheads appear to continue normal behavior at closer distances to high-resolution seismic surveys than to low-resolution seismic surveys. In the study by Richardson, Wells, and Wursig (1985), four controlled tests were conducted by firing a single 40-cubic-inch (0.66-liter) airgun at a distance of 2-5 kilometers (1.2-3.1 miles) from the whales. Bowheads sometimes continued normal activities (skim feeding, surfacing, diving, and travel) when the airgun began firing 3-5 kilometers (1.86-3.1 miles) away (received noise levels at least 118-133 dB re 1 μPa). Some bowheads oriented away during an experiment at a range of 2-4.5 kilometers (1.2-2.8 miles) and another experiment at a range of 0.2-1.2 kilometers (0.12-0.75 miles) (received noise levels at least 124-131 and 124-134 decibels, respectively). Frequencies of turns, predive flexes, and fluke-out dives were similar with and without airgun noise; and surfacing and respiration variables and call rates did not change significantly during the experiments.

IV.C.5.a(1)(a)1)b) Deep-Seismic Surveys

These surveys emit loud sounds, which are pulsed rather than continuous, and can propagate long distances from their source. Overall source levels of noise pulses from airgun arrays are very high, with peak levels of 240-250 dB re 1 μPa at 1 meter. However, most energy is directed downward, and the short duration of each pulse limits the total energy. Received levels within a few kilometers typically exceed 160 dB re 1 μPa (Richardson et al., 1995a), depending on water depth, bottom type, ice cover, etc.

Numerous studies have been conducted on the effects of noise from seismic surveys on bowhead whales. During the 1980s, the behavior of bowhead whales exposed to noise pulses from seismic surveys was observed during the summer in the Canadian Beaufort Sea and during the fall migration across the Alaskan Beaufort Sea. In general, many of the seismic surveys conducted during the 1980s were 2-dimensional seismic surveys that covered fairly large areas in deeper waters. Additional studies on seismic surveys were conducted in the central Alaskan Beaufort Sea during the fall migration in 1996-1998. These surveys were 3-dimensional seismic surveys that covered fairly small areas in relatively shallow water fairly close to shore. The results of these studies conducted during the 1980's and 1990's are discussed in the following text.

Reeves, Ljungblad, and Clarke (1983) conducted aerial surveys to observe bowhead whale behavior in the presence of active seismic vessels. Whales were observed as close as 3 kilometers (1.86 miles) and as far away as 135 kilometers (83.9 miles) from active seismic vessels. A pair of whales observed at a distance of 3 kilometers (1.83 miles) were not moving while at the surface although the two whales' heads were in contact. This pair of whales was closer to a shooting seismic vessel than any other whales observed during the study. No obvious response was apparent, but the observation time was brief. (The received level of low-frequency underwater sound from an underwater source, generally is lower by 1-7 decibels near the surface (depth of 3 meters) than at deeper (greater than 9 meters) depths (Richardson et al., 1995a). It is possible these whales may have been at the surface to avoid the louder noise in deeper water. For the group of 20 whales at a distance of approximately 135 kilometers (83.9 miles), the blow frequency per surfacing and time at the surface were greater during the period immediately after the seismic vessel began shooting than before it began shooting. The authors stated that no major changes in whale behavior (such as flight reactions) were observed that could unequivocally be interpreted as responses to seismic noise. They noted a possible exception of "huddling" behavior, which they thought may have been caused by the onset of seismic sounds. The authors concluded that although their results suggest some changes in behavior related to seismic sounds, the possibility that unquantified factors could be correlative dictates caution in attempting to establish causative explanations from the preliminary findings.

Ljungblad et al. (1985) conducted a set of four experiments where bowhead whales were approached by an operating seismic vessel. Sonobuoys were dropped near the whales to record received sound levels from the airguns and to record bowhead sounds. In Experiment 1, the *Western Beaufort* was actively shooting approximately 12 kilometers (7.5 miles) from the whales' position. A sonobuoy dropped near the whales indicated a received level of seismic sound near the whales of 131.1 dB re 1 µPa at 12 kilometers (7.5 miles). Additional seismic sounds from an unknown source also were received at the sonobuoy with a received level of 133.0 dB re 1 µPa. The *Western Beaufort* approached to within 1.3 kilometers (0.81 miles) with received sound level of 152.4 dB re 1 µPa. At 3.5 kilometers (2.18 miles), milling and social behavior ceased. Surfacing, respiration, and dive characteristics changed significantly and were accompanied with avoidance behaviors as the vessel approached to within 1.3 kilometers (0.81 miles). Because the vessel had been shooting prior to the beginning of the experiment, predisturbance observations were not obtained and postdisturbance observations were confounded by other geophysical vessels that had become active in the area. Experiment 2 involved a sudden seismic startup by the *Western Aleutian* at a range of 7.2 kilometers (4.47 miles) with a received sound level of 165 decibels. The sound level of this array at 1 meter was estimated at between 230 and 240 decibels. The *Western Aleutian* was about 12.4 kilometers (7.7 miles) from the whales and had been inactive. A sonobuoy revealed some low level seismic sound (less than 120 dB re 1 µPa) from an unknown source. The whales responded to the sudden startup of the *Western Aleutian* (165 decibels) by changing their surfacing behavior and, as the vessel approached 3.5 kilometers (2.18 miles) (170 dB), the surfacing, respiration, and dive characteristics changed significantly. In Experiment 3, the seismic vessel *Arctic Star* was approximately 15.5 kilometers (9.6 miles) from the whales and was actively shooting before the experiment. A sonobuoy dropped near the whales measured received sound levels of 148.4 dB re 1 µPa. After completing the survey line, the vessel's airguns were shut down and the vessel changed course to begin approaching the whales. The vessel activated 18 of the 24 airguns at 11.6 kilometers (7.2 miles) from the whales with an estimated sound source level of 246 dB re 1 µPa and a received level at the sonobuoy of 154.9 dB re 1 µPa. Surfacing, respiration, and dive characteristics changed significantly as the *Arctic Star* approached from 12-5 kilometers (7.5-3.1 miles) with received sound levels ranging between 154.9 and 171.2 decibels, respectively. Two whales remained until the vessel approached to within 3.5 kilometers (2.18 miles). In Experiment 4, seismic sounds from the *Western Polaris* were initiated at a distance of 11.7 kilometers (7.3 miles) with received levels of 154 dB re 1 µPa. The *Western Polaris* had been inactive before the experiment, although the *Mariner* was actively shooting at a distance of 28 kilometers (17.4 miles) from the whales with received sound levels at the whales of 120 dB re 1 µPa. Surfacing, respiration, and dive characteristics began to change at a range of 7 kilometers (4.35 miles) with a received sound level of 158.1 decibels, partial avoidance behavior began at 3.5 kilometers (2.18 miles) with a received sound level of

163.1 decibels, and complete avoidance reactions were exhibited at 1.8 kilometers (1.12 miles) when the estimated received sound level was 169 decibels. This study concluded that whales responded to seismic sounds at ranges less than 10 kilometers (6.2 miles), with the strongest responses occurring when whales were within 5 kilometers (3.1 miles) of the sound source, and that a period of 30-60 minutes is required before whales recover from the effects of close seismic disturbance. No discernable behavioral changes occurred during exposure to seismic sound at ranges greater than 10 kilometers (6.2 miles). It also was concluded that the findings in this study were consistent with the findings of several earlier studies. A subcommittee of the Scientific Committee of the International Whaling Commission reviewed this data and some members were critical of the methodology and analysis of the results.

> Comments included reference to: the small sample size; inconsistencies between the data and the conclusions; lack of documentation of calibration of sound monitoring; and possible interference from other active seismic vessels in the vicinity. The sub-committee acknowledged the difficulty of performing experiments of this kind, particularly in the absence of a 'control' environment free of industrial noise. The sub-committee recommended that additional research taking into account the concerns expressed above be undertaken, and that the 1984 experimental results be subjected to rigorous reanalysis, before it can draw any conclusions on the effects of seismic activity on this species (International Whaling Commission, 1987).

In Fraker et al. (1985), an active seismic vessel traveled toward a group of bowheads from a distance of 19 kilometers (11.8 miles) to a distance of 13 kilometers (8.18 miles). The whales did not appear to alter their general activities. Most whales surfaced and dove repeatedly and appeared to be feeding in the water column. During their repeated surfacing and dives, they moved slowly to the southeast (in the same direction as seismic-vessel travel) and then to the northwest (in the opposite direction of seismic-vessel travel). The study first stated that a weak avoidance reaction may have occurred but then stated there is no proof that the whales were avoiding the vessel. The net movement was about 3 kilometers (1.86 miles). The study found no evidence of differences in behavior in the presence and absence of seismic noise but noted that observations were limited.

In another study (Richardson, Wells, and Wursig, 1985) involving a full-scale seismic vessel with a 47-liter airgun array (estimated source level 245-252 dB re 1 μPa), bowheads began to orient away from the approaching ship when its airguns began to fire from 7.5 kilometers (4.7 miles) away. This airgun array had about 30 airguns, each with a volume of 80-125 cubic inches. The *Mariner* had been shooting seismic about 10 kilometers to the west of a group of six whales. Prior to the start of the experimental seismic period, the whales were surfacing and diving and moving at slow to medium speed while at the surface. The vessel ceased shooting and moved within 7.5 kilometers of the whales and began firing the airgun array while approaching the whales. The study reported no conspicuous change in behavior when the *Mariner* resumed shooting at 7.5 kilometers away. The bowheads continued to surface and dive, moving at slow to medium speeds. The received level was estimated at 134-138 decibels at 7 kilometers (4.35 miles). Some near-bottom feeding (evidenced by mud being brought to the surface) continued until the vessel was 3 kilometers (1.86 miles) away. The closest point of approach to any whale was approximately 1.5 kilometers (0.93 mile), with the received level probably well over 160 decibels. When the seismic vessel was within 1.5 kilometers of whales at the original location, at least two of the whales were observed to have moved about 2 kilometers to the south of the original location. The movements of the whales, at least while they were at the surface, were at the usual slow to moderate speeds. The study reported no conspicuous changes in behavior when the *Mariner* ceased shooting at 6 kilometers beyond the whales. The bowheads were still surfacing and diving and moving at slow to medium speed. The most notable change in behavior apparently involved the cessation of feeding when the vessel was 3 kilometers away. The whales began feeding again about 40 minutes after the seismic noise ceased.

While conducting a monitoring program around a drilling operation, Koski and Johnson (1987) noted that the call rate of a single observed bowhead whale increased after a seismic operation had ceased. During the 6.8 hours of observation, the whale was within 23-27 kilometers (14.3-16.8 miles) from the drillship. A seismic vessel was reported to be from 120-135 kilometers (74.58-83.9 miles) from the sonobuoy, and the two loudest calls received were determined to be approximately 7 kilometers (4.35 miles) and 9 kilometers (5.6 miles) from the sonobuoy, with received levels of 119 and 118 decibels, respectively. Approximate signal-to-noise ratios were 24 and 22 decibels, respectively. No information is provided regarding the exact distance the whale was from the operating seismic vessel. The increase in call rate was noted within

25 minutes after seismic noise ceased. It also needs to be noted that there were few, if any, calls heard during the 2 hours prior to the start of seismic operations, so it is unclear whether the increase in call rate relates to cessation of seismic noise, the presence of the operating drillship, the combination of both activities, or some other factor that occurred in the late afternoon. During this same study a subgroup of four to seven whales within a larger group (15-20 whales) was noted moving rapidly away from an approaching seismic vessel at a distance of 22-24 kilometers (13.7-14.9 miles). The received level of seismic pulses was 137 decibels at 19 kilometers (11.8 miles) from the sonobuoy and 22 kilometers from the whales. The surfacing and diving were unusually brief, and there were unusually few blows per surfacing. No information was available regarding the time required for these whales to return to normal behavior. Richardson and Malme (1993) noted that this apparent avoidance response is the longest distance avoidance of a seismic vessel documented in the studies they reviewed.

Richardson and Malme (1993), while synthesizing data on the effects of noise on bowheads, concluded that collectively, scientific studies have shown that most bowheads usually show strong avoidance response when an operating seismic vessel approaches within 6-8 kilometers (3.8-5.0 miles). Strong avoidance occurs when received levels of seismic noise are 150-180 dB re 1 μPa (Richardson and Malme, 1993). Strong pulses of seismic noise often are detectable 25-50 kilometers (15.5-31 miles) from seismic vessels, but most bowheads exposed to seismic sounds from vessels more than about 7.5 kilometers (4.7 miles) away rarely show avoidance. Seismic pulses can be detectable 100 kilometers (62.2 miles) or more away. Bowheads also may show specific behavioral changes, such as reduced surfacing, reduced dive durations; changes in respiration rates, including fewer blows per surfacing, and longer intervals between successive blows; and they may temporarily change their individual swimming paths. The authors noted that surfacing, respiration, and dive cycles may be altered in the same manner as those of whales closer to the vessels. Bowheads' surface-respiration-dive characteristics appeared to recover to pre-exposure levels within 30-60 minutes following the cessation of the seismic activity. These short-term responses are not likely to preclude a successful migration or to significantly disrupt feeding activities.

The North Slope Borough believes that many studies were different from the real-world situation, and various limitations have been pointed out. Most studies did not involve actively migrating whales; and those whales were being approached by the seismic ships whereas in the real world, the fall migrating whales are actively moving to the west and they are approaching a distant seismic boat that is firing. It is likely that some migrating bowheads show avoidance at distances exceeding those observed in studies conducted during the 1980's. Subtle shifts in direction could be occurring that cause the bowheads to be farther from shore as they gradually migrate toward the west. The MMS notes that many studies were observational and involved opportunistic sightings of whales in the vicinity of seismic operations. The studies were not designed to show whether more subtle reactions are occurring that can displace the migration corridor, so no definitive conclusions can be drawn from them on whether or not the overall fall migration is displaced by seismic activity.

Inupiat whalers suggest that the fall bowhead migration has tended to be farther offshore since seismic work began off northern Alaska. Aerial surveys have been conducted since 1979 to determine the distribution and abundance of bowhead whales in the Beaufort Sea during their fall migration. These surveys, while not designed to measure short-term bowhead whale displacement within a given year due to site-specific industrial noise, have been used for comparing the axis of the bowhead whale migration between years. Survey data from 1982-1987 were examined to determine whether industrial activity was resulting in displacement of bowhead whales further offshore (Ljungblad et al., 1988). It was determined that a good indicator of annual shifts in bowhead distribution could be obtained by analyzing the distance of random bowhead sightings from shore (Zeh, as cited in Ljungblad et al., 1988). An analysis of the distance of random bowhead sightings from shore (a total of 60 bowhead sightings) was conducted, but no significant differences were detected in the bowhead migratory route between years. The axis of the bowhead migratory route near Barrow was found to fall between 18 and 30 kilometers (7.76 and 18.6 miles) from shore. Although the analysis involved a relatively small sample size, these observations provide some insight into migration patterns during these years. The North Slope Borough, in a letter dated July 25, 1997, questioned the sample size and the precision of the Ljungblad et al. (1988) report to determine whether or not a displacement of fall migrating whales had occurred and how big a displacement would have to be before it could be detected.

As a follow up to work described in Ljungblad et al. (1988), Moore and Clark (1992) analyzed between-year data from 1982-1989 to determine the mean distance from shore of the fall migration of bowhead whales near Barrow, Alaska, irrespective of industrial activity. Because sample sizes in 1982, 1985, 1986, 1988, and 1989 were too small for calculating Confidence Intervals for the median distances, only ANOVA and Tukey tests on mean values were applied. A power analysis showed that a 12-kilometer (7 statute miles) shift in mean bowhead whale distance from shore would give a 90% chance of finding a significant difference ($\alpha = 0.05$) using these tests. Moore and Clark (1992) found that annual mean distances from shore ranged between 25 and 36 kilometers (15 and 22 statute miles), and they detected no difference between possible pairs of years. Because the ANOVA test requires large sample sizes for detecting small shifts in whale migrations, the MMS Bowhead Whale Aerial Survey Project also uses the Mann Whitney U test, one of the most powerful nonparametric tests for testing the significance of between-year differences in water depth used by bowhead whales during their fall migrations across the Alaskan Beaufort Sea. Using larger sample sizes (for which confidence intervals were calculated) obtained over a larger study area, the aerial survey project found many between-year (1982-1996) differences in the median water depth at whale sightings that were highly significant (P less than 0.05) (Treacy, 1997). Median depths ranged between 18 meters (59 feet) in 1989 and 347 meters (1,138 feet) in 1983, with an overall cumulative depth of 37 meters (121 feet, confidence interval = 37-38 meters). The aerial survey project has reported a potential association between water depth of the bowhead migration and general ice severity, especially in 1983, when severe ice cover may have forced the axis of the migration into waters 347 meters (1,138 feet) deep. To address short-term bowhead whale displacement within a given year from site-specific industrial noise, the MMS and the National Marine Fisheries Council require industry to conduct site-specific monitoring programs when industrial activity occurs during fall bowhead migrations.

A committee of the National Research Council, in commenting on the effects of industrial noise on marine mammals, including bowhead whales, stated that it is possible to argue at great length about the validity of individual studies, but the overriding issue is that there is widespread distrust of the results and dissatisfaction with the design of studies in arctic and other communities. Because the issue is so complicated, compounded by small sample sizes and interannual variability, further studies are unlikely to resolve it soon (National Research Council, 1994). The committee stated that the best (and perhaps only) solution is for MMS, the industry, and North Slope residents to attempt to reach agreement on the controversial matters and how they should be adjusted, remedied, or mitigated—as to specific times and places that various activities occur—in lieu of or concurrent with additional studies. Along those lines, the MMS has included, as part of the lease sales in recent years, a stipulation requiring the lessee to consult with potentially affected subsistence communities to discuss siting, timing, and methods of proposed operations and safeguards or mitigating measures that could be implemented by the operator to prevent unreasonable conflicts. Since 1995, consultations between the Alaska Eskimo Whaling Commission and lessees have resulted in Conflict Avoidance Agreements that require operators to cease geophysical operations east of Cross Island after August 31 until subsistence-whaling activities in the area have been completed. Measures such as these are intended to help ensure that disturbance to the subsistence bowhead whale hunt will be minimized.

Since 1996, seismic surveys in State of Alaska waters and adjacent nearshore Federal waters of the central Alaskan Beaufort Sea have been ocean-bottom cable surveys. These surveys have been 3-dimensional seismic programs. The area to be surveyed is divided into patches, each patch being approximately 5.9 by 4.0 kilometers in size. Within each patch, several receiving cables are laid parallel to each other on the seafloor. Seismic data are acquired by towing the airguns along a series of source lines oriented perpendicular to the receiving cables. While seismic-data acquisition is ongoing on one patch, vessels are deploying cable on the next patch to be surveyed, and/or retrieving cables from a patch where seismic surveys have been completed. Airgun arrays have varied in size each year from 1996-1998 with the smallest, a 560-cubic-inch array with 8 airguns, and the largest, a 1,500-cubic-inch array with 16 airguns. A marine mammal and acoustical monitoring program was conducted in conjunction with the seismic program each year in accordance with provisions of the National Marine Fisheries Service Incidental Harassment Authorization. One of the dominant considerations during the design of the marine mammal monitoring program was the need to determine whether any displacement of the bowhead whale migration corridor occurred during seismic surveys. The monitoring program each year was designed to take into account both the results of previous scientific studies and the experience of subsistence whalers.

LGL Ltd.; Environmental Research Assocs., Inc.; and Greeneridge Sciences Inc. conducted a marine mammal monitoring program for a seismic survey near the Northstar Development Project in 1996 (Miller et al., 1997). The marine mammal monitoring program was continued for subsequent seismic surveys in nearshore waters of the Beaufort Sea in 1997 and 1998 (Miller, Elliot, and Richardson, 1998; Miller et al., 1999). Sightings and sighting rates are based on combined data from LGL and MMS aerial surveys for all areas, excluding sightings during poor sighting conditions, as presented in Miller et al. (1999). During LGL and MMS surveys in 1996, there were 32 bowhead sightings during periods with no seismic operations and 11 sightings during periods with seismic operations, with sightings per 100-kilometer flight transect of 0.49 and 0.40, respectively. In 1997, there were 160 bowhead sightings during periods with no seismic operations and 6 sightings during periods with seismic operations, with sightings per 100-kilometer flight transect of 1.56 and 1.62, respectively. Bad weather during September 1997 resulted in numerous operational shutdowns, limiting the number of sightings during active seismic work. In 1998, there were 103 bowhead sightings during periods with no seismic operations and 116 sightings during periods with seismic operations, with sightings per 100-kilometer flight transect of 0.67 and 0.69, respectively. Sighting rates in the region from about 20 kilometers east to about 20 kilometers west of seismic operations were significantly lower during seismic operations than when no seismic operations were ongoing.

Survey data from 1996, 1997, and 1998 monitoring programs were analyzed to determine the general position of the bowhead migration corridor at times with and without seismic activity. The results revealed no clear effect of the 1996 and 1997 seismic programs on the position to the general migration corridor in the central Alaskan Beaufort Sea. In 1996, bowhead sightings were fairly broadly distributed between the 10-meter- and 50-meter-depth contours. However, the analyses were limited by the low number of sightings potentially influenced by seismic. In 1997, nearly all bowhead sightings were in relatively nearshore waters. Bowhead sightings were fairly broadly distributed between the 10-meter- and 40-meter-depth contours, unusually close to shore. Many aggregations of feeding whales were observed near or just shoreward of the 10-meter-depth contour. In 1998, the bowhead-migration corridor generally was farther offshore than in either 1996 or 1997, between the 10-meter- and 100-meter-depth contours and approximately 10-60 kilometers from shore. The distributions of sightings during periods with and without seismic exploration broadly overlapped. The 1996-1998 combined survey data indicated that sighting distributions tended to be farther offshore on days with seismic operations compared to days with no seismic operations, based on sightings per 100 kilometers of survey effort. This was true for the study area as a whole, for the east region, and marginally so for the west region. The same tendency was evident in the central region, but was not statistically significant.

During aerial surveys from 1996-1998, bowheads rarely were observed closer than 20 kilometers from seismic vessels when airguns were operating. The sighting rate within 20 kilometers of seismic operations was reduced significantly. However, the authors stated this effect should be interpreted cautiously, given the small sample size during times of active seismic operations. Avoidance reactions, rather than differences in sightability, are believed to be the main reasons for the lack of sightings during aerial surveys near operating seismic vessels. One bowhead was seen only 70 meters from the operating seismic vessel by boat-based observers in 1997, so not all bowheads avoided the area within 20 kilometers of the seismic vessel. Overall, the 1996-1998 results show that most bowheads avoided the area within about 20 kilometers of the operating airguns. Bowhead avoidance of the area within 20 kilometers of where active seismic operations had occurred in 1996-1998 did not persist beyond about 12 hours after the end of seismic operations. Within 12-24 hours after seismic operations ended, the sighting rate within 20 kilometers was similar to the sighting rate beyond 20 kilometers.

Based on 1996-1998 data, there was little or no evidence that bowhead headings, general activities, or swimming speeds were affected by seismic exploration. Bowheads approaching from the northeast and east showed similar headings at times with and without seismic operations. Miller et al. (1999) stated that the lack of any statistically significant differences in headings should be interpreted cautiously. Changes in headings must have occurred given the avoidance by most bowheads of the area within 20 or even 30 kilometers of active seismic operations. Westbound bowheads must have turned to the right at some point as they approached the seismic operation. Miller et al. (1999) noted that the distance at which deflection began cannot be determined precisely, but they stated that considering times with operations on offshore patches, deflection may have begun about 35 kilometers to the east. However, some bowheads approached within 19-21 kilometers of the airguns when they were operating on the offshore patches. It appears that in

1998, the offshore deflection might have persisted for at least 40-50 kilometers west of the area of seismic operations. In contrast, during 1996-1997 there were several sightings in areas 25-40 kilometers west of the most recent shotpoint, indicating the deflection in 1996-1997 may not have persisted as far to the west. General activities of bowheads were similar at times that were and were not influenced by seismic during 1996-1998. There also was little indication of differences in swimming speed with and without seismic operations.

The LGL and Greeneridge studies in 1996-1998 also recorded bowhead whale calls. Greene et al. (1999), summarizing the 3 years of study, stated the results are consistent in indicating that: (1) bowhead whales call frequently during the autumn migration through the study area; (2) calling continued at times when whales were exposed to airgun pulses; and (3) call detection rates at some locations differed significantly when airguns were detectable versus not detectable. However, there was no significant tendency for call-detection rate to change in a consistent way at times when airguns started or stopped. In 1998, more calls were detected at a site near the 25-meter-depth contour offshore of the survey area during times with airgun operations than without airgun operations. In contrast, fewer calls were detected during 1996 at a site near the 25-meter-depth during times with airgun operations than without airgun operations. Conversely, more calls were detected at a site farther offshore during times when seismic operations were closer to shore than at times without seismic operations. The 1996 results are consistent with the hypothesis that exposure of bowheads traveling along the southern part of the migration corridor to seismic noise resulted in whales diverting to the north, a reduced calling rate, or some combination of the two.

During the 1996-1998 bowhead hunting seasons, seismic operations were moved to locations well west of Cross Island, the area where Nuiqsut-based whalers hunt for bowheads (Miller et al., 1999). This was done under the provisions of the Conflict Avoidance Agreements established between industry and the hunters in 1996-1998. No perceived interference between seismic operations and hunting was reported either in 1998 or in 1996-1997. As a result of mitigating measures implemented under the 1996-1998 Conflict Avoidance Agreements, the 1996-1998 seismic surveys did not adversely affect the accessibility of bowheads to subsistence whalers (Miller et al., 1999).

In summary, the LGL and Greeneridge 1996-1998 monitoring studies found that the bowhead whale-migration corridor in the central Alaskan Beaufort Sea during 1998 was similar to the corridor in many prior years, although not 1997. In 1997, nearly all bowheads sighted were in relatively nearshore waters. The results of the 1996-1998 studies indicated a tendency for the general bowhead whale-migration corridor to be farther offshore on days with seismic airguns operating compared to days without seismic airguns operating, although the distances of bowheads from shore during airgun operations overlapped with those in the absence of airgun operations. However, aerial-survey results indicated that bowheads tended to avoid the area around the operating source, perhaps to a radius of about 20-30 kilometers. Sighting rates within a radius of 20 kilometers of seismic operations were significantly lower during seismic operations than when no seismic operations were happening. Within 12-24 hours after seismic operations ended, the sighting rate within 20 kilometers was similar to the sighting rate beyond 20 kilometers. There was little or no evidence of differences in headings, general activities, and swimming speeds of bowheads with and without seismic operations. The observed 20-30 kilometer area of avoidance is a larger avoidance radius than documented by previous scientific studies in the 1980’s and smaller than the 30 miles suggested by subsistence whalers, based on their experience with the types of seismic operations that occurred in the Beaufort Sea before 1996 (Richardson, 2000). Whales avoiding seismic operations during the 1996-1998 whaling seasons did not affect the accessibility of bowheads for subsistence whaling.

Richardson provided a brief comparison between observations from seismic studies conducted in the 1980s and the 1996 seismic survey at the Arctic Seismic Synthesis Workshop in Barrow (USDOI, MMS, Alaska OCS Region, 1997). Observations from earlier seismic studies during the summer and early autumn show that most bowhead whales interrupt their previous activities and swim strongly away when a seismic ship approaches within about 7.5-8 kilometers. At the distances where this strong avoidance occurs, received levels of seismic pulses typically are high, about 150-180 dB re 1 µPa. The surfacing, respiration, and dive cycles of bowheads engaged in strong avoidance also change in a consistent pattern involving unusually short surfacing and diving, and unusually few blows per surfacing. These avoidance and behavioral effects among bowheads close to seismic vessels are strong, reasonably consistent, and relatively easy to document. Less consistent and weaker disturbance effects probably extend to longer distances and lower received sound levels at least some of the time. Bowheads often tolerate much seismic noise and, at least in summer, continue to use areas where seismic exploration is common. However, the same pattern of change in surfacing, respiration, and diving cycles has sometimes been seen in bowheads as much as 73 kilometers from seismic ships. Most of these whales were engaged in seemingly normal activities, and were not swimming away from the seismic boat. However, at least one case of strong avoidance has been reported as far as 24 kilometers from an approaching seismic boat (Koski and Johnson 1987). Richardson and Malme (1993) noted that the apparent avoidance response observed by Koski and Johnson was the longest distance of a seismic vessel documented in the studies they had reviewed.

Richardson noted that many of the observations involved bowheads that were not actively migrating. Actively migrating bowheads may react somewhat differently than bowheads engaged in feeding or socializing. Migrating bowheads, for instance, may react by deflecting their migration corridor away from the seismic vessel. Monitoring of the bowhead migration past a nearshore seismic operation in September 1996 provided evidence consistent with the possibility that the closest whales may have been displaced several miles seaward during periods with seismic activity. Even so, the main migration corridor during times with seismic activity was within 20-30 kilometers from shore and within 10-20 kilometers of the closest edge of the area with seismic exploration, well within the ensonified area.

With respect to these studies conducted in the Beaufort Sea from 1996-1998, the peer-review group at the Arctic Open-Water Noise Peer Review Workshop in Seattle from June 5-6, 2001, prepared a summary statement supporting the methods and results reported in Richardson (1999) concerning avoidance of seismic sounds by bowhead whales:

> Monitoring studies of 3-D seismic exploration (8-16 airguns totaling 560-1500 in^3) in the nearshore Beaufort Sea during 1996-1998 have demonstrated that nearly all bowhead whales will avoid an area within 20 km of an active seismic source, while deflection may begin at distances up to 35 km. Sound levels received by bowhead whales at 20 km ranged from 117-135 dB re 1μPa rms and 107-126 dB re 1μPa rms at 30 km. The received sound levels at 20-30 km are considerably lower levels than have previously been shown to elicit avoidance in bowhead or other baleen whales exposed to seismic pulses.

A recent study in Canada provides information on the behavioral response of bowhead whales in feeding areas to seismic surveys (Miller and Davis, 2002). During the late summer and autumn of 2001, Anderson Resources Ltd. conducted an open-water seismic exploration program offshore of the Mackenzie Delta in the Canadian Beaufort Sea. The program consisted of streamer seismic surveys and associated bathymetric surveys conducted off the Mackenzie Delta. The bathymetric surveys were conducted by two medium-sized vessels equipped with side-scan sonar and single-beam echosounders. The seismic vessel was the *Geco Snapper*. The acoustic sources used in the seismic operations were two 2,250 cubic inch arrays of 24 sleeve-type airguns. Each 2,250 cubic inch airgun array was comprised of 24 airguns with volumes ranging from 40-150 cubic inches. The two airgun arrays fired alternately every 8 seconds along the survey lines. The airgun arrays were operated at a depth of 5 meters below the water surface. Water depths within the surveyed areas ranged from 6-31 meters and averaged 13 meters (Miller, 2002).

Because marine seismic projects using airgun arrays emit strong sounds into the water and have the potential to affect marine mammals, there was concern about the acoustic disturbance of marine mammals and the potential effects on the accessibility of marine mammals to subsistence hunters. Although there are no prescribed marine mammal and acoustic monitoring requirements for marine seismic programs in the Canadian Beaufort Sea, it was decided that monitoring and mitigation measures in the Canadian Beaufort Sea should be as rigorous as those designed and implemented for marine seismic programs conducted in the Alaskan Beaufort Sea in recent years. The monitoring program consisted of three primary components: acoustic measurements, vessel-based observations, and aerial surveys. The National Marine Fisheries Service recommended criterion that exposure of whales to impulse sound not exceed 180 dB re 1μPa rms (65 *FR* 16374) was adopted as a mitigation standard for this monitoring program. Estimates of sound-propagation loss from the airgun array were used to determine the designated 1000-meter safety radius for whales (the estimated zone within which received levels of seismic noise were 180 dB re 1μPa rms or higher).

Aerial and vessel-based surveys confirmed the presence of substantial numbers of bowheads offshore of the Mackenzie Delta from late August until mid-September. The distribution of bowheads in the study area was typical of patterns observed in other years and suggests that there were good feeding opportunities for bowheads in these waters during that period.

A total of 262 bowheads were observed from the seismic vessel *Geco Snapper* (Moulton, Miller, and Serrano, 2002). Sighting rates during daylight hours were higher when no airguns were operating than during periods with airguns operating. During the period when bowheads were most abundant in the study area (August 23-September 19), the bowhead sighting rate during periods with no seismic (0.85 bowheads/hour) was about twice as high as that recorded during periods with seismic (0.40 bowheads/hour) or all seismic operations combined (0.44 bowheads/hour). Average sighting distances from the vessel were significantly ($P < 0.001$) lower during no guns (a mean radial distance of 1,368 meters) versus line-seismic periods (a mean radial distance of 1,957 meters). The observed difference in sighting rates and the significant difference in sighting distances suggest that bowheads did avoid close approach to the area of seismic operations. However, the still substantial number of sightings during seismic periods and the relatively short (600-meter) but significant difference in sighting distances suggests that the avoidance was localized and relatively small in nature. At a minimum, the distance by which bowheads avoided seismic operations was on the order of 600 meters greater than the average distance by which they avoided general vessel operations. The lower sighting rates recorded during seismic operations suggest that some bowheads avoided the seismic operations by larger distances and, thereby, stayed out of visual range of the marine mammal observers on the *Geco Snapper*.

A total of 275 bowhead whale sightings were recorded during aerial transects with good lighting conditions (Holst et al., 2002). Bowheads were sighted at similar rates with and without seismic, although the no-seismic sample was too small for meaningful comparisons. Bowheads were seen regularly within 20 kilometers of the operations area at times influenced by airgun pulses. Of 169 transect sightings in good conditions, 30 sightings were seen within 20 kilometers of the airgun operations at distances of 5.3-19.9 kilometers. The aerial surveys were unable to document bowhead avoidance of the seismic operations area. The area of avoidance around the seismic operations area was apparently too small to be evident from the broad-scale aerial surveys that were flown, especially considering the small amount of surveying done when seismic was not being conducted. General activities of bowheads during times when seismic operations were conducted were similar to times without seismic.

The bowheads that surfaced closest to the vessel (323-614 meters) would have been exposed to sound levels of about 180 dB re 1 µPa rms before the immediate shutdown of the array (Miller et al., 2002). There were seven shutdowns of the airgun array in response to sightings of bowheads within 1 kilometer of the seismic vessel. Bowheads at the average vessel-based sighting distance (1,957 meters) during line seismic would have been exposed to sound levels of about 170 dB re 1 µPa rms. The many aerial sightings of bowheads at distances from the vessel ranging from 5.3-19.9 kilometers would have been exposed to sound levels ranging from approximately 150-130 dB re 1 µPa rms, respectively.

The results from the present study in summer 2001 are markedly different from those obtained during similar studies during the autumn migration of bowheads through the Alaskan Beaufort Sea (Miller et al., 2002). For example, during the Alaskan studies only 1 bowhead whale was observed from the seismic vessel(s) during six seasons (1996-2001) of vessel-based observations compared with 262 seen from the *Geco Snapper* in 2001. The zone of avoidance for bowhead whales around the airgun operations in 2001 was clearly much smaller (~2 kilometers) than that observed for migrating bowhead whales in recent autumn studies in Alaskan waters (up to 20-30 kilometers). Davis (1987) concluded that migrating bowheads during the fall migration may be more sensitive to industrial disturbance than bowheads on their summering grounds, where they may be engaged in feeding activities.

Inupiat subsistence whalers have stated that industrial noise, especially noise due to seismic exploration, has displaced the fall bowhead migration seaward and, thereby, is interfering with the subsistence hunt at Barrow (Ahmaogak, 1989). Dr. Tom Albert, testifying at the Barrow public hearing on the Beaufort Sea Sale 144 draft EIS, said the whaling captains believe most bowheads are likely to show avoidance response to seismic operations at greater distances. "[T]he hunters that go out, feel that the reaction is on the order of a 10 miles or more..." (USDOI, MMS, 1995b). Fred Kanayurak and 16 other whaling captains from Barrow, Nuiqsut, and Kaktovik, in written testimony at the Arctic Seismic Synthesis and Mitigating Measures Workshop on March 5-6, 1997 in Barrow (USDOI, MMS, Alaska OCS Region, 1997) stated: "Factual experience of subsistence whalers testify that pods of migrating bowhead whales will begin to divert from their migratory path at distances of 35 miles from an active seismic operation and are displaced from their normal migratory path by as much as 30 miles." Also at the March 1997 workshop, Mr. Roxy Oyagak, Jr., a Nuiqsut whaling captain, stated in written testimony: "Based on the industrial activity, there is an unmitigable adverse impact on the village of Nuiqsut on subsistence whaling. i.e., 1) by causing the whales to abandon the hunting area, and 2) directly displacing the subsistence whalers, and 3) placing physical barriers between the subsistence whalers and marine mammals, including altering the normal bowhead whale migration route."

Seismic activity should have little effect on zooplankton. Bowheads feed on concentrations of zooplankton. Zooplankton that are very close to the seismic source may react to the shock wave, but little or no mortality is expected (LGL Ltd., 2001). A reaction by zooplankton to a seismic impulse would be relevant only if it caused a concentration of zooplankton to scatter. Pressure changes of sufficient magnitude to cause zooplankton to scatter probably would occur only if they were very close to the source. Impacts on zooplankton behavior are predicted to be negligible and would have negligible effects on feeding bowheads (LGL Ltd., 2001).

Sale-specific effects likely would be similar to those discussed above. However, the effect on whales from future seismic activity in the Beaufort Sea should be less than from previous activities during the 1980's and 1990's, because a substantial amount of seismic work, especially low-resolution, deep-seismic, already has been conducted in the area. Geophysical surveys conducted in conjunction with the multiple-sale program are likely to cover much smaller areas to fill in gaps from earlier seismic surveys. Also, some of the seismic work that is needed may be conducted when whales are not present in the area.

There is concern about industrial activities in the spring lead system. The general location of the spring lead system in the Beaufort Sea is based on relatively limited survey data and is not well defined. Noise-producing activities, such as seismic surveys, in the spring lead system during the spring bowhead migration have a fairly high potential of affecting the whales. Seismic surveys are not expected to be conducted in or near the spring lead system through which bowheads migrate because (1) degraded ice conditions would not allow on-ice surveys, and (2) insufficient open water is present for open-water seismic surveys.

IV.C.5.a(1)(a)2) Effects from Drilling Operations

Exploration-drilling units are another source of noise. Exploration drilling in the Beaufort Sea can be conducted from manmade gravel islands, ice islands, caisson-retained islands, bottom-founded drilling platforms such as the concrete island drilling system or steel drilling caisson, or from drillships in deeper water supported by icebreakers. The type of drilling platform used depends on water depth, oceanography, ice cover, and other factors. Stationary sources of offshore noise (such as drilling units) appear less disruptive to bowhead whales than moving sound sources (such as vessels). Drilling operations from most of these structures except drillships are likely to be conducted during the winter months. Drilling from ice islands would occur only during the winter when bowheads are not present, so noise from these activities would not affect bowhead whales. Therefore, this type of drilling activity is not discussed here.

As stated previously, the general location of the spring lead system in the Beaufort Sea is based on relatively limited survey data and is not well defined. Noise-producing activities, such as drilling operations, in the spring lead system during the spring bowhead migration have a fairly high potential of affecting the whales. The MMS believes that exploratory drilling operations using floating platforms within the spring lead system during the spring bowhead migration are unlikely, because the ice at this time of year would be too thick for floating drilling platforms to get to the location and conduct drilling operations, even with icebreaker support. Spring-migrating bowheads are not likely to be exposed to drilling noise from activities on Sale 186, Sale 195, or Sale 202 leases. Areas in or near the spring lead system could be leased during these sales, but any exploratory drilling operations likely would be conducted during the open-water season (August-October) using floating drilling platforms.

Some bowheads in the vicinity of drilling operations would be expected to respond to noise from drilling units by slightly changing their migration speed and swimming direction to avoid closely approaching these noise sources. Miles, Malme, and Richardson (1987) predicted the zone of responsiveness to continuous noise sources. They predicted that roughly half of the bowheads likely would respond at a distance of 0.02-0.2 kilometers (0.12-1.12 miles) to drilling from an artificial island when the signal-to-noise ratio is 30 decibels. By comparison, they predicted that roughly half of the bowheads likely would respond at a distance of 1-4 kilometers (0.62-2.5 miles) from a drillship drilling when the signal-to-noise ratio is 30 decibels. A smaller proportion would react when the signal-to-noise ratio is about 20 decibels (at a greater distance from the source), and a few may react at a signal-to-noise ratio even lower or at a greater distance from the source.

Although underwater sounds from drilling on some artificial islands and caissons have been measured, little information is available about reactions of bowheads to drilling from these structures. Underwater noise levels from drilling operations on natural barrier islands or artificial islands are low and are not audible beyond a few kilometers (Richardson et al., 1995a). Noise is transmitted very poorly from the drill-rig machinery through land into the water. Even under open-water conditions, drilling sounds are not detectable very far from the structure. Drilling noise from caisson-retained islands is much stronger. At least during open-water conditions, noise is conducted more directly into the water than from island drill sites. Noise associated with drilling activities at both sites varies considerably with ongoing operations. The highest documented levels were transient pulses from hammering to install conductor pipe.

IV.C.5.a(1)(a)2)a) Drilling Operations from Artificial Gravel Islands

The following is a brief discussion of several studies on the measurement of underwater noise and the effects of noise from drilling operations on gravel islands on bowhead whales.

Seal Island: Noise measurements were made during the open-water season near Seal Island, a manmade gravel island off Prudhoe Bay in water 12 meters deep. Davis, Greene, and McLaren (1985) measured underwater noise from Seal Island during the open-water season while well logging was occurring but not drilling operations. Underwater sound levels recorded from bottom hydrophones 1.65-2.4 kilometers from Seal Island were strongly affected by wind speed and active barge or tug traffic at the island. The strongest tone measured was 486 hertz from turbochargers on the generators used for well-logging operations. This tone was measured by a hydrophone on a boat at distances of up to 5 kilometers from Seal Island. Noise associated with barge or tug movement at the island could be readily detected at 2.4 kilometers from the island, even during high winds. Noise levels in the 20-1,000-Hertz band from barge traffic were about 118 dB re 1 μPa at 1.6 kilometers and had decreased to 108-110 dB re 1 μPa at 2.4 kilometers. At that rate of sound attenuation, the noise level from barges was estimated to be about 92 decibels at 6 kilometers. Underwater sounds from Seal Island were not detectable 2.3 kilometers away while people were on the island and power generators were operating, but no logging or drilling operations were ongoing.

Aerial surveys for bowhead whales near Seal Island in 1982 (during island construction) and 1984 found that most whales were in waters deeper than 18 meters, which is consistent with data from previous studies (Davis, Greene, and McLaren, 1985). In 1982, one whale was sighted in 12 meters of water about 11 kilometers northwest of Seal Island. In 1984, there were two sightings of single whales in 12-15 meters of water. Whales migrating in waters deeper than 18 meters would have been too far away to detect noise from Seal Island, because industrial noise was not audible in the water more than a few kilometers away. Acoustic data collected in 1982 and 1984 suggest that some bowheads were closer to Seal Island in 1984 than in 1982. Localizations made by the hydrophone array on three occasions indicated the whales were present between 2.5 and 6 kilometers from Seal Island. Bowhead calls recorded on hydrophones were thought to be from whales that were in waters at least 18 meters deep. The study concluded that there was no evidence to suggest that bowheads avoided Seal Island in 1984 compared to 1982.

Sandpiper Island: Johnson et al. (1986) measured underwater noise from Sandpiper Island, a manmade gravel island in water 15 meters deep. Sound was measured using a bottom-hydrophone system at 0.5 kilometers from the island and sonobuoys at greater distances from the island. The median sound levels observed at a fixed location 0.5 kilometers from Sandpiper Island were relatively low. Median noise levels in the 20-1,000-Hertz band were 93 and 95 dB re 1 μPa during 2 periods without drilling and 100 dB re 1 μPa during 1 period with drilling. In the absence of shipping or other industrial sounds, the expected level of noise in the 20-1,000-Hertz band is about 100 dB re 1 μPa for Beaufort Sea State 2 conditions (wind speeds at 7-10 knots and wave heights up to 0.5 meter). The most obvious components were tones at 20 and 40 Hertz, which were attributed to power generation on the island.

The low-frequency industrial sounds from Sandpiper Island attenuated rapidly with increasing range, at least partially due to the shallow water. The low-frequency sounds were evident when ambient noise levels were low but were largely masked during periods when ambient noise was above average. Sound levels received at a sonobuoy 3.7 kilometers from Sandpiper Island (76 dB re 1 µPa in both the 20- and 40-Hertz bands) were 24-30 decibels lower than the levels received at the bottom hydrophone 0.5 kilometers from the island. The bottom hydrophone measured drilling sounds of 100 dB re 1 µPa in the 20-Hertz frequency band at 0.5 kilometers from Sandpiper Island. The sounds were severely attenuated at 3.7 kilometers and not detectable at 9.3 kilometers. The effective source level of the 40-Hertz tone was estimated at 145 dB re 1 µPa at 1 meter.

Impulsive hammering sounds associated with installation of a conductor pipe were as high as 131-135 dB re 1 µPa at 1 kilometer, when pipe depth was about 20 meters below the island. In contrast, broadband drilling noise at this distance was about 100-106 decibels. During hammering, the transient signals had the strongest components at 30-40 Hertz and about 100 Hertz. Moore et al. (1984, as cited in Richardson, et al., 1995b) reported that received levels for transient pile-driving sounds recorded at 1 kilometer from a manmade island near Prudhoe Bay were 25-35 decibels above ambient levels in the 50- to 200-Hertz band. They estimated that the sounds might be received underwater as far as 10-15 kilometers from the source, farther than drilling sounds.

Aerial surveys for bowhead whales in 1985 indicated that no bowheads were seen closer than 30 kilometers from Sandpiper Island (Johnson et al., 1986). Almost all of the migrating bowheads traveled in water deeper than 18 meters, as was found in the surveys for Seal Island. Sandpiper and Northstar islands are both about 6 kilometers south of the 18-meter-depth contour. No drilling occurred at Sandpiper Island between September 4 and October 12, 1985, although drilling did resume a few days before the migration ended. Industrial noise from Sandpiper Island, with or without drilling, was not audible in the water more than a few kilometers away. Because the migration route of almost all bowheads is north of the 18-meter contour, few individual whales moved into the zone where industrial noise potentially was detectable.

The authors concluded that the number of whales that passed along the southern edge of the migration route and approached the artificial islands, both Seal and Sandpiper, must have been a very low fraction of the total population given the absence of sightings close to the islands.

Tern Island: Studies at Tern Island (proposed Liberty Island location) were conducted to determine sound levels that could be expected from the proposed Liberty development project. The studies provide information on distances that sound travels as a result of activities on gravel islands.

Greene (1997) measured underwater sounds under the ice at the proposed Liberty Island location from drilling operations on Tern Island in Foggy Island Bay in February 1997. Sounds from the drill rig generally were masked by ambient noise at distances near 2 kilometers. The strongest tones were at frequencies below 170 hertz, but the received levels diminished rapidly with increasing distance and dropped below the ambient noise level at ranges of about 2 kilometers. Drilling sounds were not detected at frequencies above 400 Hertz, even at 200 meters from the drill rig.

Greene noted that if production proceeded at Liberty, the types and frequency characteristics of some of the resulting sounds would be similar to those from the drilling equipment in this study. Electric power generation, pumps, and auxiliary machinery again would be involved, as would a drill rig during the early stages of production. However, the production island also would include additional processing and pumping facilities. If this equipment requires significantly more electric power, generators may produce sounds that are detectable at greater distances. However, these sounds would diminish rapidly with increasing distances due to high spreading losses (35 decibels per tenfold change in range) plus the linear attenuation rates of 2-9 decibels per kilometer (0.002-0.009 decibels per meter). Sound transmission within the lagoon for activities at Liberty would be similar to the sound transmission measured for activities at Tern Island, but the barrier islands to the north and the lagoon's very shallow water near those islands should make underwater sound transmission very poor beyond the islands and into the Beaufort Sea.

Greene (1998) measured ambient noise and acoustic-transmission loss underwater at the proposed Liberty Island site in Foggy Island Bay during the open-water season of 1997 to complement transmission loss and ambient-noise measurements made under the ice at Liberty in February 1997. For wind speeds of zero, 10, 20, and 30 knots, typical overall ambient noise levels in the 20-5000-Hertz band were 85, 94, 104, and 114 dB re 1 μPa, respectively. For the data from both recorders taken together, the median 20-5,000-Hertz band level for the 44 days was 97 dB re 1 μPa, or 9 decibels above the corresponding level for Knudsen's standard for Sea State 0 (Greene, 1998). The levels were consistent with other ambient noise measurements made in similar locations at similar times of the year. The measured ambient levels in winter generally were lower than those measured in summer, which means that industrial sounds would be expected to be detectable at greater distances during the winter. Bowheads are not present in the winter.

Acoustic-transmission loss was measured using a four-element sleeve-gun array and a minisparker as sources. The sleeve-gun array is a relatively low-frequency source (63-800 Hertz) compared to the minisparker (315-3,150 Hertz). Received sounds were recorded quantitatively at distances up to 8.1 kilometers southeast and 10.1 kilometers north of Liberty. At greater distances (up to 10 kilometers), the sounds from the sleeve-gun array diminished generally according to -25 log(R), while the minisparker sound diminished at approximately -10 log(R), corresponding to cylindrical spreading. This difference is attributed to the sleeve-gun array being a low-frequency source compared to the minisparker. Propagation-loss rates varied with frequency. The minisparker had a higher linear loss rate, which corresponds to higher absorption and scattering losses at higher frequencies.

Richardson et al. (1995a) summarized that noise from drilling activities varies considerably with operations. The highest documented levels were transient pulses from hammering to install conductor pipe. Underwater noise associated with drilling from natural barrier or artificial islands usually is weak and is inaudible beyond a few kilometers. Richardson et al. (1995a) estimated that drilling noise generally would be confined to low frequencies and would be audible at a range of 10 kilometers only during unusually quiet periods, while the audible range under more typical conditions would be approximately 2 kilometers.

IV.C.5.a(1)(a)2)b) Drilling Operations from Bottom-Founded Structures

Two types of caissons have been used for offshore drilling in the Alaska Beaufort Sea: the concrete island drilling system, which is a floating concrete rig that is floated into place, ballasted with seawater, and sits on the seafloor; and the steel drilling caisson, which is a section of a ship with a drill rig mounted on it and also is floated into place, ballasted with seawater, and sits on the seafloor. Drilling from these platforms generally is initiated after the bowhead whale migration is done and continues through the winter season.

In the absence of drilling operations, radiated levels of underwater sound from the concrete island drilling system were low, at least at frequencies above 30 Hertz. The overall received level was 109 dB re 1 μPa at 278 meters, excluding any infrasonic components. When the concrete island drilling system was drilling in early winter, radiated sound levels above 30 Hertz again were relatively low (89 decibels at 1.4 kilometer). However, when infrasonic components were included, the received level was 112 decibels at 1.4 kilometer. More than 99% of the sound energy received was below 20 Hertz. Received levels of sound at 222-259 meters ranged from 121-124 decibels. The maximum detection distance for infrasonic sounds was not determined. Such tones likely would attenuate rapidly in water shallow enough for a bottom-founded structure. Overall, the estimated source levels were low for the concrete island drilling system, even when the infrasonic tones were included (Richardson et al., 1995a).

Sounds from the steel drilling caisson were measured during drilling operations in water 15 meters deep with 100% ice cover. The strongest underwater tone was at 5 Hertz (119 dB re μPa) at a distance of 115 meters. The 5-Hertz tone apparently was not detectable at 715 meters, but weak tones were present at 150-600 Hertz. The broadband (20-1000 Hertz) received level at 215-315 meters was 116-117 dB re μPa, higher than the 109 decibels reported for the concrete island drilling system at 278 meters.

Inupiat whalers believe that noise from drilling activities displace whales farther offshore away from their traditional hunting areas. These concerns were expressed primarily for drilling activities from drillships with icebreaker support that were operating offshore in the main migration corridor. Concerns also have been expressed about noise generated from the single steel drilling caisson, the drilling platform used to drill two wells on the Cabot Prospect east of Barrow in October 1990 and November 1991. Mr. Jacob Adams, Mr. Burton Rexford, Mr. Fred Kanayurak, and Mr. Van Edwardson, all with the Barrow Whaling Captain's Association, stated in written testimony at the Arctic Seismic Synthesis and Mitigating Measures Workshop on March 5-6, 1997, in Barrow: "We are firmly convinced that noise from the Cabot drilling platform displaced whales from our traditional hunting area. This resulted in us having to go further offshore to find whales" (USDOI, MMS, Alaska OCS Region, 1997). The two wells drilled for the Cabot Prospect were spudded on October 19, 1990, and November 1, 1991, respectively.

IV.C.5.a(1)(a)2)c) Drilling Operations from Drillships and other Floating Platforms

Bowhead whales whose behavior appeared normal have been observed on several occasions within 10-20 kilometers (6.2-12.4 miles) of drillships in the eastern Beaufort Sea, and there have been a number of reports of sightings within 0.2-5 kilometers (0.12-3 miles) from drillships (Richardson et al., 1985b; Richardson and Malme, 1993). On several occasions, whales were well within the zone where drillship noise should be clearly detectable by them.

Richardson and Malme (1993) point out that the data, although limited, suggest that stationary industrial activities producing continuous noise, such as stationary drillships, result in less dramatic reactions by bowheads than do moving sources, particularly ships. It also appears that bowhead avoidance is less around an unattended structure than one attended by support vessels. Most observations of bowheads tolerating noise from stationary operations are based on opportunistic sightings of whales near ongoing oil-industry operations, and it is not known whether more whales would have been present in the absence of those operations. Because other cetaceans seem to habituate somewhat to continuous or repeated noise exposure when the noise is not associated with a harmful event, this suggests that bowheads will habituate to certain noises that they learn are nonthreatening. However, in Canada, bowhead use of the main area of oil-industry operations within the bowhead range was low after the first few years of intensive offshore oil exploration in 1976 (Richardson, Wells, and Wursig, 1985), suggesting perhaps cumulative effects from repeated disturbance may have caused the whales to leave the area. In the absence of systematic data on bowhead summer distribution until several years after intensive industry operations began, it is arguable whether the changes in distribution in the early 1980s were greater than natural annual variations in distribution, such as responding to changes in the location of food sources. Ward and Pessah (1988) concluded that the available information from 1976-1985 and the historical whaling information do not support the suggestion of a trend for decreasing use of the industrial zone by bowheads as a result of oil and gas exploration activities. They concluded that the exclusion hypothesis is likely invalid.

The distance at which bowheads may react to drillships is difficult to gauge, because some bowheads would be expected to respond to noise from drilling units by changing their migration speed and swimming direction to avoid closely approaching these noise sources. For example, in the study by Koski and Johnson (1987), one whale appeared to adjust its course to maintain a distance of 23-27 kilometers (14.3-16.8 miles) from the center of the drilling operation. Migrating whales apparently avoided the area within 10 kilometers (6.2 miles) of the drillship, passing both to the north and to the south of the drillship. The study detected no bowheads within 9.5 kilometers (5.9 miles) of the drillship, and few were observed within 15 kilometers (9.3 miles). The principal finding of this study was that migrating bowheads appeared to avoid the offshore drilling operation in fall 1986.

In other studies, Richardson, Wells, and Wursig (1985) observed three bowheads 4 kilometers (2.48 miles) from operating drillships, well within the zones ensonified by drillship noise. The whales were not heading away from the drillship but were socializing, even though exposed to strong drillship noise. Eleven additional whales on three other occasions were observed at distances of 10-20 kilometers (6.2-12.4 miles) from operating drillships. On two of the occasions, drillship noise was not detectable by researchers at distances from 10-12 kilometers (6.2-7.4 miles) and 18-19 kilometers (11.2-11.8 miles), respectively. In none of the occasions were whales heading away from the drillship. Ward and Pessah (1988, as cited in Richardson and Malme, 1993) reported observations of bowheads within 0.2-5 kilometers (0.12-3 miles) from drillships.

The ice-strengthened Kulluk, a specialized floating platform designed for arctic waters, was used for drilling operations at the Kuvlum drilling site in western Camden Bay in 1992 and 1993. Data from the Kulluk indicated broadband source levels (10-10,000 Hertz) during drilling and tripping were estimated to be 191 and 179 dB re μPa at 1 meter, respectively, based on measurements at a water depth of 20 meters in water about 30 meters deep (Richardson et al., 1995a).

Hall et al. (1994) conducted a site-specific monitoring program around the Kuvlum drilling site in the western portion of Camden Bay during the 1993 fall bowhead whale migration. Results of their analysis indicated that bowheads were moving through Camden Bay in a significantly nonrandom pattern but became more randomly distributed as they left Camden Bay and moved to the west. The results also indicated that whales were distributed farther offshore in the proximal survey grid (near the drill site) than in the distant survey grid (an area east of the drill site), which is similar to results from previous studies in this general area. The authors noted that information from previous studies indicated that bowheads routinely were present nearshore to the east of Barter Island and were less evident close to shore from Camden Bay to Harrison Bay (Moore and Reeves, as cited in Hall et al., 1994). The authors believed that industrial variables such as received level were insufficient as a single predictor variable to explain the 1993 offshore distribution of bowhead whales, and they suggested that water depth was the only variable that accounted for a significant portion of the variance in the model. They concluded that for 1993, water depth, received level, and longitude accounted for 85% of the variance in the offshore distribution of the whales. Based on their analyses, the authors concluded that the 1993 bowhead whale distribution fell within the parameters of previously recorded fall-migration distributions.

Davies (1997) used the data from the Hall et al. study in a geographic-information system model to analyze the distribution of fall-migrating bowheads in relation to an active drilling operation. He also concluded that the whales were not randomly distributed in the study area, and that they avoided the region surrounding the drill site at a range of approximately 20 kilometers (12.4 miles). He also noted that the whales were located significantly farther offshore and in significantly deeper water in the area of the drilling rig. As noted by Hall et al. (1994), the distribution of whales observed in the Camden Bay area is consistent with previous studies (Moore and Reeves, 1993), where whales were observed farther offshore in this portion of the Beaufort Sea than they were to the east of Barter Island. Davies concluded, as did Hall et al., that it was difficult to separate the effect of the drilling operation from other independent variables. The model identified distance from the drill rig and water depth as the two environmental factors that were most-strongly associated with the observed distribution of bowheads in the study area. The Davies analysis, however, did not note that surface observers (Hall et al., 1994) observed whales much closer to the drilling unit and support vessels than did aerial observers. In one instance, a whale was observed approximately 400 meters (436 yards) from the drill rig. Hall et al. suggest that bowheads, on several occasions, were closer to industrial activity than would be suggested by an examination of only aerial-survey data.

Schick and Urban (2000) also analyzed data from the Hall et al. study and tested the correlation between bowhead whale distribution and variables such as water depth, distance to shore, and distance to the drilling rig. The distribution of bowhead whales around the active drilling rig in 1993 was analyzed and the results indicated that whales were distributed farther from the drilling rig than they would be under a random scenario. The area of avoidance was localized and temporary (Schick and Urban, 2000; Angliss and Lodge, 2002). Schick and Urban (2000) stated they could not conclude that noise from the drilling rig caused the low density near the rig, because they had no data on actual noise levels. They also noted that ice, an important variable, is missing from their model and that 1992 was a particularly heavy ice year. Because ice may be an important patterning variable for bowheads, Schick and Urban said they were precluded from drawing strong inference from the 1992 results with reference to the interaction between whales and the drilling rig. Moore and DeMaster (1998, as cited in Schick and Urban, 2002) proposed that migrating bowheads are often found farther offshore in heavy ice years because of an apparent lack of feeding opportunities. Schick and Urban (2002) stated that ultimately, the pattern in the 1992 data may be explained by the presence of ice rather than by the presence of the drilling rig.

In playback experiments, some bowheads showed a weak tendency to move away from the sound source at a level of drillship noise comparable to what would be present several kilometers from an actual drillship (Richardson and Malme, 1993). In one study, sounds recorded 130 meters (426 feet) from the actual Karluk drill rig were used as the stimulus during disturbance test playbacks (Richardson et al., 1991). For the overall 20- to 1,000-Hertz band, the average source level was 166 dB re 1 μPa in 1990 and 165 dB re 1 μPa in 1989. Bowheads continued to pass the projector while normal Karluk drilling sounds were projected. During the playback tests, the source level of sound was 166 dB re 1 μPa. One whale came within 110 meters (360 feet) of the projector. Many whales came within 160-195 meters (525-640 feet), where the received broadband (20-1000 Hertz) sound levels were about 135 dB re 1 μPa. That level was about 46 decibels above the background ambient level in the 20- to 1,000-Hertz band on that day. Bowhead movement patterns were strongly affected when they approached the operating projector. When bowheads still were several hundred meters away, most began to move to the far side of the lead from the projector, which did not happen during control periods while the projector was silent.

In a subsequent phase of this continuing study, Richardson et al. (1995b) concluded:

> …migrating bowheads tolerated exposure to high levels of continuous drilling noise if it was necessary to continue their migration. Bowhead migration was not blocked by projected drilling sounds, and there was no evidence that bowheads avoided the projector by distances exceeding 1 kilometer (0.54 nautical mile). However, local movement patterns and various aspects of the behavior of these whales were affected by the noise exposure, sometimes at distances considerably exceeding the closest points of approach of bowheads to the operating projector.

Some migrating bowheads diverted their course enough to remain a few hundred meters to the side of the projector. Surfacing and respiration behavior, and the occurrence of turns during surfacings, were strongly affected out to 1 kilometer (0.62 mile). Turns were unusually frequent out to 2 kilometers (1.25 miles), and there was evidence of subtle behavioral effects at distances up to 2-4 kilometers (1.25-2.5 miles). The study concluded that the demonstrated effects were localized and temporary and that playback effects of drilling noise on distribution, movements, and behavior were not biologically significant.

The authors stated that one of the main limitations of this study (during all 4 years) was the inability of a practical sound projector to reproduce the low-frequency components of recorded industrial sounds. Both the Karluk rig and the icebreaker Robert Lemeur emitted strong sounds down to ~10-20 Hertz, and quite likely at even lower frequencies. It is not known whether the under-representation of low-frequency components (less than 45 Hertz) during icebreaker playbacks had significant effects on the responses by bowheads. Bowheads presumably can hear sounds extending well below 45 Hertz. It is suspected but not confirmed that their hearing extends into the infrasonic range below 20 Hertz. The authors believed the projector adequately reproduced the overall 20- to 1,000-Hertz level at distances beyond 100 meters (109 yards), even though components below 80 Hertz were under-represented. If bowheads are no more responsive to sound components at 20-80 Hertz than to those above 80 Hertz, then the playbacks provided a reasonable test of the responsiveness to components of Karluk sound above 20 Hertz.

The authors also stated that the study was not designed to test the potential reactions of whales to nonacoustic stimuli detected via sight, olfaction, etc. At least in summer/autumn, responses of bowheads to actual dredges and drillships seem consistent with reactions to playbacks of recorded sounds from those same sites. Additional limitations of the playbacks identified by the authors included low sample sizes and the fact that responses were only evident if they could be seen or inferred based on surface observations. The numbers of bowhead whales observed during both playback and control conditions were low percentages of the total Beaufort Sea population. Also, differences between whale activities and behavior during playback versus control periods represent the incremental reactions when playbacks are added to a background of other activities associated with the research. Thus, playback results may somewhat understate the differences between truly undisturbed whales versus those exposed to playbacks.

If drillships are attended by icebreakers, as typically is the case during the fall in the U.S. Beaufort Sea, the drillship noise frequently may be masked by icebreaker noise, which often is louder. There are no observations of bowhead reactions to icebreakers breaking ice. Response distances would vary, depending on icebreaker activities and sound-propagation conditions. Based on models, bowhead whales likely would respond to the sound of the attending icebreakers at distances of 2-25 kilometers (1.24-15.53 miles) from the icebreakers (Miles, Malme, and Richardson, 1987). Zones of responsiveness for intermittent sounds, such as an icebreaker pushing ice have not been studied. This study predicts that roughly half of the bowhead whales show avoidance response to an icebreaker underway in open water at a range of 2-12 kilometers (1.25-7.46 miles) when the sound-to-noise ratio is 30 decibels. The study also predicts that roughly half of the bowhead whales would show avoidance response to an icebreaker pushing ice at a range of 4.6-20 kilometers (2.86-12.4 miles) when the sound-to-noise ratio is 30 decibels.

Richardson et al. (1995b) found that bowheads migrating in the nearshore lead often tolerated exposure to projected icebreaker sounds at received levels up to 20 decibels or more above the natural ambient noise levels at corresponding frequencies. The source level of an actual icebreaker is much higher than that of the projectors (projecting recorded sound) used in this study (median difference 34 decibels over the frequency range 40-6,300 Hertz). Over the two-season period (1991 and 1994) when icebreaker playbacks were attempted, an estimated 93 bowheads (80 groups) were seen near the ice camp when the projectors were transmitting icebreaker sounds into the water, and approximately 158 bowheads (116 groups) were seen near there during quiet periods. Some bowheads diverted from their course when exposed to levels of projected icebreaker sound greater than 20 decibels above the natural ambient noise level in the one-third octave band of the strongest icebreaker noise. However, not all bowheads diverted at that sound-to-noise ratio, and a minority of whales apparently diverted at a lower sound-to-noise ratio. The study concluded that exposure to a single playback of variable icebreaker sounds can cause statistically but probably not biologically significant effects on movements and behavior of migrating whales in the lead system during the spring migration east of Point Barrow. The study indicated the predicted response distances for bowheads around an actual icebreaker would be highly variable; however, for typical traveling bowheads, detectable effects on movements and behavior are predicted to extend commonly out to radii of 10-30 kilometers (6.2-18.6 miles) and sometimes to 50+ kilometers (31.1 miles). Effects of an actual icebreaker on migrating bowheads, especially mothers and calves, could be biologically significant. It should be noted that these predictions were based on reactions of whales to playbacks of icebreaker sounds in a lead system during the spring migration and are subject to a number of qualifications. (The predicted "typical" radius of responsiveness around an icebreaker like the *Robert Lemeur* is quite variable, because propagation conditions and ambient noise vary with time and with location. In addition, icebreakers vary widely in engine power and thus noise output, with the *Robert Lemeur* being a relatively low-powered icebreaker. Furthermore, the reaction thresholds of individual whales vary by at least 10 decibels around the "typical" threshold, with commensurate variability in predicted reaction radius.)

While conducting aerial surveys over the Kuvlum drilling location, Brewer et al. (1993) showed that bowhead whales were observed within about 30 kilometers (18.6 miles) north of the drilling location. The closest observed position for a bowhead whale detected during the aerial surveys was approximately 23 kilometers (14.3 miles) from the project icebreakers. The drilling rig was not operating on that day, but all three icebreakers had been actively managing ice periodically during the day. The study did not indicate what the whale's behavior was, but it did not appear to be avoiding the icebreakers. Three whales were sighted that day, and all three appeared to be moving to the northwest along the normal migration route at speeds of 2.4-3.4 kilometers per hour (1.5-2.1 miles per hour). Bowhead whale call rates peaked when whales were about 32 kilometers (19.9 miles) from the industrial activity. There was moderate to heavy ice conditions throughout the monitoring area, with heavy, grounded icefloes to the west, north, and east of the drilling site. Generally, whales tend to be located in deeper waters during years of moderately heavy ice cover (Treacy, 1993). Brewer et al. (1993) were unable to determine if either ice or industrial activity by themselves caused the whales to migrate to the north of the drilling location, but they concluded that ice alone probably did not determine the observed distribution of whales.

Concerns have been raised regarding the effects of noise from OCS exploration and production operations in the spring lead system and the potential for this noise to delay or block the bowhead spring migration. Spring-migrating bowheads are not likely to be exposed to drilling noise. To date, no drilling or production operations have taken place in the vicinity of the spring lead system during the bowhead migration.

IV.C.5.a(1)(a)3) Effects from Aircraft Traffic

Most offshore aircraft traffic in support of the oil industry involves turbine helicopters flying along straight lines. Underwater sounds from aircraft are transient. According to Richardson et al. (1995a), the angle at which a line from the aircraft to the receiver intersects the water's surface is important. At angles greater than 13° from the vertical, much of the incident sound is reflected and does not penetrate into the water. Therefore, strong underwater sounds are detectable while the aircraft is within a 26° cone above the receiver. An aircraft usually can be heard in the air well before and after the brief period while it passes overhead and is heard underwater.

Data on reactions of bowheads to helicopters are limited. Most bowheads are unlikely to react significantly to occasional single passes by low-flying helicopters ferrying personnel and equipment to offshore operations. Observations of bowhead whales exposed to helicopter overflights indicate that most bowheads exhibited no obvious response to helicopter overflights at altitudes above 150 meters (500 feet). At altitudes below 150 meters (500 feet), some bowheads probably would dive quickly in response to the aircraft noise (Richardson and Malme, 1993). However, bowhead reactions to a single helicopter flying overhead probably are temporary (Richardson et al., 1995a). This noise generally is audible for only a brief time (tens of seconds) if the aircraft remains on a direct course, and the whales should resume their normal activities within minutes. Patenaude et al. (1997) found that most reactions by bowheads to a Bell 212 helicopter occurred when the helicopter was at altitudes of 150 meters or less and lateral distances of 250 meters or less. The most common reactions were abrupt dives and shortened surface time, and most, if not all, reactions seemed brief. However, the majority of bowheads showed no obvious reaction to single passes, even at those distances. The helicopter sounds measured underwater at depths of 3 and 18 meters showed that sound consisted mainly of main-rotor tones ahead of the aircraft and tail-rotor sounds behind the aircraft; more sound pressure was received at 3 meters than at 18 meters; and peak sound levels received underwater diminished with increasing aircraft altitude. Sound levels received underwater at 3 meters from a Bell 212 flying overhead at 150 meters ranged from 117-120 dB re 1 μPa in the 10- to 500-Hertz band. Underwater sound levels at 18 meters from a Bell 212 flying overhead at 150 meters ranged from 112-116 dB re 1 μPa in the 10- to 500-Hertz band.

Fixed-wing aircraft flying at low altitude often cause hasty dives. Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 meters (1,000 feet), uncommon at 460 meters (1,500 feet), and generally undetectable at 600 meters (2,000 feet). Repeated low-altitude overflights at 150 meters (500 feet) during aerial photogrammetry studies of feeding bowheads sometimes caused abrupt turns and hasty dives (Richardson and Malme, 1993). Aircraft on a direct course usually produce audible noise for only tens of seconds, and the whales are likely to resume their normal activities within minutes (Richardson and Malme, 1993). Patenaude et al. (1997) found that few bowheads (2.2%) during the spring migration were observed to react to Twin Otter overflights at altitudes of 60-460 meters. Reaction frequency diminished with increasing lateral distance and with increasing altitude. Most observed reactions by bowheads occurred when the Twin Otter was at altitudes of 182 meters or less and lateral distances of 250 meters or less. There was little, if any, reaction by bowheads when the aircraft circled at an altitude of 460 meters and a radius of 1 kilometer. The effects from an encounter with aircraft are brief, and the whales should resume their normal activities within minutes.

IV.C.5.a(1)(a)4) Effects from Vessel Traffic

Bowheads react to the approach of vessels at greater distances than they react to most other industrial activities. According to Richardson and Malme (1993), most bowheads begin to swim rapidly away when vessels approach rapidly and directly. Avoidance usually begins when a rapidly approaching vessel is 1-4 kilometers (0.62-2.5 miles) away. A few whales may react at distances from 5-7 kilometers (3-4 miles), and a few whales may not react until the vessel is less than 1 kilometer (less than 0.62 mile) away. Received noise levels as low as 84 dB re 1 μPa) or 6 decibels above ambient may elicit strong avoidance of an approaching vessel at a distance of 4 kilometers (2.5 miles) (Richardson and Malme, 1993).

In the Canadian Beaufort Sea, bowheads observed in vessel-disturbance experiments began to orient away from an oncoming vessel at a range of 2-4 kilometers (1.2-2.5 miles) and to move away at increased speeds when approached closer than 2 kilometers (1.2 miles) (Richardson and Malme, 1993). Vessel disturbance during these experimental conditions temporarily disrupted activities and sometimes disrupted social groups, when groups of whales scattered as a vessel approached. Reactions to slow-moving vessels, especially if they do not approach directly, are much less dramatic. Bowheads often are more tolerant of vessels moving slowly or in directions other than toward the whales. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period. After some disturbance incidents, at least some bowheads returned to their original locations (Richardson and Malme, 1993). Some whales may exhibit subtle changes in their surfacing and blow cycles, while others appear to be unaffected. Bowheads actively engaged in social interactions or mating may be less responsive to vessels.

Bowhead whales probably would encounter relatively few vessels associated with exploration activities during their fall migration through the Alaskan Beaufort Sea. Vessel traffic generally would be limited to routes between the exploratory-drilling units and the shore base. Each floating drilling unit probably would have one vessel remaining nearby for emergency use. Depending on ice conditions, floating drilling units may have two or more icebreaking vessels standing by to perform ice-management tasks. It is likely that vessels actively involved in ice management or moving from one site to another would be more disturbing to whales than vessels idling or maintaining their position. In either case, bowheads probably would adjust their individual swimming paths to avoid approaching within several kilometers of vessels attending a drilling unit and probably would move away from vessels that approached within a few kilometers. Vessel activities associated with exploration are not expected to disrupt the bowhead migration, and small deflections in individual bowhead-swimming paths and a reduction in use of possible bowhead-feeding areas near exploration units should not result in significant adverse effects on the species. During their spring migration (April through June), bowheads likely would encounter few, if any, vessels along their migration route, because ice at this time of year typically would be too thick for seismic-survey ships, drillships, and supply vessels to operate in.

IV.C.5.a(1)(a)5) Effects from Other Exploration Activities

Island-construction activities could cause noise and disturbance to bowhead whales. Placement of fill material for island construction generally occurs during the winter when bowhead whales are not present. Completion of island construction and placement of slope-protection materials may take place during the open-water season, but these activities generally are completed before the bowhead whale fall migration. Placement of sheetpile, if used, would generate noise during the open-water period for one construction season but also should be completed in early to mid-August, before the whales migrate. Noise is not likely to propagate far due to the shallow water and the presence of barrier islands that, in many cases, may lie between the drilling location and the migration corridor used by bowhead whales, depending on the island location. Even during the migration, noise from these activities would be minor and would not affect bowhead whales.

Preliminary analysis of noise measurements during the open-water construction season at Northstar Island by Blackwell and Greene (2001) indicated that the presence of self-propelled barges had the largest impact on the level of sound coming from Northstar Island. Self-propelled barges remained at Northstar for days or weeks and always had their engines running, because they maintained their position by "pushing" against the island. Sound measurements on a day when there were no self-propelled barges showed that sounds were inaudible to the field acoustician listening to the hydrophone signal beyond 1.85 kilometers, even on a relatively calm day. By comparison, the sounds produced by self-propelled barges, while limited in their frequency range, were detectable underwater as far as 28 kilometers north of the island. Other vessels, such as the crew boat and tugs, produced qualitatively the same types of sounds, but they were present intermittently, and their effect on the sound environment was lower.

Summary of Noise Effects: Bowheads are not affected much by any aircraft overflights at altitudes above 300 meters (984 feet). Below this altitude, some changes in whale behavior may occur, depending on the type of plane and the responsiveness of the whales present in the vicinity of the aircraft. The effects from such an encounter with either fixed-wing aircraft or helicopters generally are brief, and the whales should resume their normal activities within minutes. Bowheads may exhibit temporary avoidance behavior if approached by vessels at a distance of 1-4 kilometers (0.62-2.5 miles). Marine-vessel traffic also may include seagoing barges transporting equipment and supplies from Southcentral Alaska to drilling locations, most likely between mid-August and mid- to late September. If the barge traffic continues into September, some bowheads may be disturbed. Fleeing behavior from vessel traffic generally stopped within minutes after the vessel passed, but scattering may persist for a longer period. In some instances, at least some bowheads returned to their original locations. In many cases, vessel activities are likely to be in shallow, nearshore waters outside the main bowhead-migration route.

Several studies indicate that most bowheads exhibit avoidance behavior when exposed to sounds from seismic activity at a distance of a few kilometers but rarely show avoidance behavior at distances of more than 7.5 kilometers (4.7 miles). Bowheads also exhibited tendencies for reduced surfacing and dive duration, fewer blows per surfacing, and longer intervals between successive blows. Bowheads appeared to recover from these behavioral changes within 30-60 minutes following cessation of seismic activity. However, recent monitoring studies (1996-1998) indicate that during the fall migration, most bowhead whales avoid an area around a seismic vessel operating in nearshore waters by a radius of about 20 kilometers. The sighting rates of whales at a radius of 20 and 30 kilometers was higher than the sighting rate within the 20-kilometer radius, but it varied annually from no evidence of a reduced sighting rate in 1996 to a reduced sighting rate in 1998. This is a larger avoidance radius than was observed from scientific studies conducted in the 1980's. Avoidance did not persist beyond 12 hours after the end of seismic operations.

Exploratory drilling from gravel islands generally is conducted during the winter. Should these activities occur during the migration, noise produced from the activities is not expected to affect whales, because gravel islands are constructed in fairly shallow water shoreward of the main migration route, and noise from operations on gravel islands generally is not audible beyond a few kilometers. Exploratory drilling from bottom-founded structures also generally is conducted during the winter. Bowheads have been sighted within 0.2-5 kilometers (0.12-3 miles) from drillships, although some bowheads probably change their migration speed and swimming direction to avoid close approach to noise-producing activities. A few bowheads may avoid drilling noise at 20 kilometers (12.4 miles) or more. If icebreakers attended drillships, as typically is the case during the fall in the U.S. Beaufort Sea, the drillship noise frequently may be masked by icebreaker noise, which often is louder. There are no observations of bowhead reactions to icebreakers breaking ice, but it has been predicted that roughly half of the bowheads would respond at a distance of 4.6-20 kilometers (2.86-12.4 miles) when the sound-to-noise ratio is 30 decibels. Whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources.

Island-construction activities likely will be conducted during the winter and generally are in nearshore shallow waters shoreward of the main bowhead whale migration route. These activities are not expected to affect bowhead whales. Some whales may be displaced seaward, if cleanup activities occurred outside the barrier islands or in the channels between the barrier islands during the whale migration.

Bowheads do not seem to travel more than a few kilometers in response to a single disturbance incident and behavioral changes are temporary, lasting from minutes (in the case of vessels and aircraft) up to 30-60 minutes (in the case of seismic activity in earlier seismic studies). In recent studies, avoidance of the area within 20 kilometers of seismic operations did not persist beyond 12 hours after the end of seismic operations. Occasional brief interruption of feeding by a passing vessel or aircraft probably is not of major significance. Similarly, the energetic cost of traveling a few additional kilometers to avoid closely approaching a noise source is very small in comparison with the cost of migration between the central Bering and eastern Beaufort seas. We do not believe these disturbances or avoidance factors will be significant, because the anticipated level of industrial activity is not sufficiently intense to cause repeated displacement of specific individuals. Reactions are less obvious in the case of industrial activities that continue for hours or days, such as distant seismic exploration and drilling. Behavioral studies have suggested that bowheads habituate to noise from distant, ongoing drilling or seismic operations (Richardson et al., 1985), but there still is some apparent localized avoidance (Davies, 1987). There is insufficient evidence to indicate whether or not industrial activity in an area for a number of years would adversely impact bowhead use of that area (Richardson et al., 1985), but there has been no documented evidence that noise from OCS operations would serve as a barrier to migration.

Overall, bowhead whales exposed to noise-producing activities such as vessel and aircraft traffic, drilling operations, seismic surveys, and construction activities most likely would experience temporary, nonlethal effects.

IV.C.5.a(1)(b) Effects from Discharges

There also could be a number of minor alterations in bowhead habitat as a result of exploration. Discharge of drilling muds and cuttings during exploration activities are not expected to cause significant effects, either directly through contact or indirectly by affecting prey species. Any effects would be primarily localized around the drill rig because of the rapid dilution/deposition of these materials. Bottom-founded drilling units and/or gravel islands may cover small areas of benthic habitat, and drilling muds and cuttings may cover portions of the seafloor that support epibenthic invertebrates used for food by bowhead whales. However, the effects likely would be negligible, because bowheads feed primarily on pelagic zooplankton and the areas of sea bottom that are impacted would be inconsequential in relation to the available habitat. Gravel-island-construction activities, including placement of fill material, or installation of sheetpile or gravel bags for slope protection would cause sediment suspension or turbidity in the water. It is likely that most of these construction activities would occur during the winter when bowheads are not present in the area. Activities occurring during the open-water season likely would be completed before the bowhead whales begin their fall migration. Bowheads should not be affected by these activities.

IV.C.5.a(1)(c) Effects of an Oil Spill on Bowhead Whales

The effects of an oil spill on bowhead whales are unknown. However, some conclusions can be drawn from studies that have looked at the effects of oil spills on other cetaceans. Engelhardt (1987) theorized that bowhead whales would be particularly vulnerable to effects from oil spills during their spring migration into arctic waters because of their use of ice edges and leads, where spilled oil tends to accumulate. Several other researchers (Geraci and St. Aubin, 1982; St. Aubin, Stinson, and Geraci, 1984) concluded that exposure to spilled oil is unlikely to have serious direct effects on baleen whales. Other studies (Loughlin, 1994; Dahlheim and Matkin, 1994; Dahlheim and Loughlin, 1990) either documented no effects to cetaceans from spilled oil, or the results of the studies were inconclusive. In the unlikely event of a large oil spill in the bowhead whale's habitat while they were present, some whales could experience the following (Geraci, 1990):

- oiling of skin
- inhaling of hydrocarbon vapors (from a fresh spill)
- ingesting contaminated prey
- fouling of their baleen
- reduced food source
- displacement from feeding areas
- death
- other effects

The number of whales contacting spilled oil would depend on the size, timing, and duration of the spill; how many whales were near the spill; and the whales' ability or inclination to avoid contact.

IV.C.5.a(1)(c)1) Effects of Skin Contact

Oil first would contact a whale's skin as it surfaces to breathe. The effects of oil contacting skin are largely speculative. Although oil is unlikely to adhere to smooth skin, it may stick to rough areas on the surface. Henk and Mullan (1997) studied skin lesions on bowheads and categorized them as shallow lacerations, circular depressions, and epidermal sloughing. All lesions remain on the top layer of the skin and produce no inflammation or other response. They stated that whatever the cause or form of the lesion, a layer of cells builds up next to the affected area. This layer eventually moves to the surface and heals the lesion without scarring. The authors suggest that a layer of cells on an otherwise smooth skin surface may increase the potential for petroleum to adhere.

Haldiman et al. (1981) also describe the skin and lesions on the skin of bowheads. Haldiman et al. (1985) detail the skin's structure, finding the epidermal layer to be as much as 7-8 times thicker than that found on most whales. This study included some very simple preliminary trials to determine possible interactions between bowhead skin and crude oil. The researchers found that little or no crude oil adhered to preserved bowhead skin that was dipped into oil up to three times, as long as a water film stayed on the skin's surface. Oil adhered in small patches to the surface and vibrissae (stiff, hairlike structures), once it made enough contact with the skin. The amount of oil sticking to the surrounding skin and epidermal depression appeared to be in proportion to the number of exposures and the roughness of the skin's surface.

Albert (1981) suggests that oil would adhere to the skin's rough surfaces (eroded areas on the skin's surface, tactile hairs, and depressions around the tactile hairs). Albert (1996, as cited in U.S. Army Corps of Engineers, 1998:Appendix B) characterizes the rough areas as variable in size and shape, often 1-2 inches in diameter and 1-3 millimeters deep, with hairlike projections extending up from the depths of the damaged skin surface. He theorizes that oil could irritate the skin, especially the eroded areas, and interfere with information the animal receives through the tactile hairs. Because we do not know how these hairs work, we cannot assess how any damage to them might affect bowheads. Albert (1981) is concerned that the eroded skin may provide a point of entry into the bloodstream for pathogenic bacteria, if the skin becomes more damaged. Shotts et al. (1990) found a large number of species of bacteria and yeast, both from the normal skin and from lesions on bowheads. Enzymatic assays from isolates from normal skin and skin with lesions demonstrated the production of enzymes capable of causing necrosis (tissue death). The presence of the enzymes suggests that the lesions are active sites of necrosis. The authors noted that 38% of the microorganisms in lesions contained enzymes necessary for hemolytic activity of blood cells (breaking down of red blood cells and the release of hemoglobin) compared to 28% of the microorganisms on normal skin. Many of these species of bacteria and yeast were determined to be potential pathogens of mammalian hosts. Hansen (1985) speculates that much of the oil is washed off the whale's skin as it moves through the water. However, we do not know how long spilled oil will adhere to the skin of a free-ranging whale. Oil might wash off the skin and body surface shortly after bowheads vacated oiled areas, if they left shortly after being oiled. However, oil might adhere to the skin and other surface features (such as sensory hairs) longer, if bowheads remained in these areas.

There is speculation that bowhead whale eyes may be vulnerable to damage from oil on the water due to their unusual anatomical structure.

In a study on nonbaleen whales and other cetaceans, Harvey and Dahlheim (1994) observed 80 Dall's porpoises, 18 killer whales, and 2 harbor porpoises in oil on the water's surface from the *Exxon Valdez* spill. They observed groups of Dall's porpoises on 21 occasions in areas with light sheen, several occasions in areas with moderate-to-heavy surface oil, once in no oil, and once when they did not record the amount of oil. Thirteen of the animals were close enough to determine if oil was present on their skin. They confirmed that 12 animals in light sheen or moderate-to-heavy oil did not have oil on their skin. One Dall's porpoise had oil on the dorsal half of its body. It appeared stressed because of its labored breathing pattern. The authors gave no other information on effects. The 18 killer whales and 2 harbor porpoises were in oil but had none on their skin. None of the cetaceans appeared to alter their behaviors when in areas where oil was present. The authors concluded their observations were consistent with other reports of cetaceans behaving normally when oil is present. It is probable that bowhead whales would respond in a similar manner (U.S. Army Corps of Engineers, 1998:Appendix B).

Histological data and ultrastructural studies by Geraci and St. Aubin (1990) showed that long exposures to petroleum hydrocarbons produced only transient damage to epidermal cells in whales. The authors began their experiments by applying a small sponge soaked in crude oil to the skin of four species of toothed whales. Contact for up to 45 minutes had no effect. They switched to gasoline and applied the sponge up to 75 minutes. Even unrealistically long contact times could not produce a severe reaction typical of that in other mammals. Subtle changes were evident only at the cell level and, in each case, healed within a week. The authors pointed out that a cetacean's skin is an effective barrier to the noxious substances in petroleum. These substances normally damage skin by getting between cells and dissolving protective lipids. In cetacean skin, however, tight intercellular bridges, vital surface cells, and the extraordinary thickness of the epidermis impeded the damage. The authors could not detect a change in lipid concentration between and within cells after exposing skin from a white-sided dolphin to gasoline for 16 hours in vitro.

Geraci and St. Aubin also investigated how oil might affect healing of superficial wounds in a bottlenose dolphin's skin. They found that following a cut, newly exposed epidermal cells degenerate to form a zone of dead tissue that shields the underlying cells from seawater during healing. They massaged the superficial wounds with crude oil or tar for 30 minutes, but the substances did not affect healing. Lead-free gasoline applied in the same manner caused strong inflammation, but it subsided within 24 hours and was indistinguishable from control cuts. The authors concluded that the dead tissue had protected underlying tissues from gasoline in the same way it repels osmotic attack by seawater. The authors further concluded that in real life, contact with oil would be less harmful to cetaceans than they and others had proposed.

Bratton et al. (1993) synthesized studies on the potential effects of contaminants on bowhead whales. They say no published data prove oil fouling of the skin of any free-living whales, and conclude that bowhead whales contacting fresh or weathered petroleum are unlikely to suffer harm. Cetacean skin is a strong barrier to the toxic effects of petroleum.

IV.C.5.a(1)(c)2) Effects of Inhalation

Bowheads would be most likely to contact spilled oil as they surface to breathe. They probably would not inhale oil into the blowhole, although bowheads surfacing in a spill of lightly weathered oil could inhale some hydrocarbon vapors that might affect breathing. Geraci and St. Aubin (1982) calculated the concentrations of hydrocarbons associated with a theoretical spill of a typical light crude oil. They calculated the concentrations of the more volatile fractions of crude oil in air. The results showed that vapor concentrations could reach critical levels for the first few hours after a spill. If a whale or dolphin were unable to leave the immediate area of a spill during that time, it would inhale some vapors, perhaps enough to cause some damage. Although the vapor concentrations would not reach levels high enough to threaten normal, healthy individuals, cetaceans that were stressed by lung and liver parasites or adrenal disorders might be vulnerable. A panicked or swiftly moving whale or dolphin would breathe rapidly and probably inhale more vapors. More likely, the animals would experience some irritation of respiratory membranes and absorb hydrocarbons into the bloodstream. Fraker (1984), while reviewing the effects of oil on cetaceans, stated that a whale surfacing in an oil spill will inhale vapors of the lighter petroleum fractions, and many of these can be harmful in high concentrations. Animals that are away from the immediate area or that are exposed to oils that had weathered for at least 2-4 hours would not be expected to suffer any consequence from inhalation, regardless of their condition. The most serious situation would occur if oil spilled into a lead that bowheads could not escape. In this case, Bratton et al. (1993) theorized the whales could inhale oil vapor that would irritate their mucous membranes or respiratory tract. They also could absorb volatile hydrocarbons into the bloodstream. However, they rapidly would excrete these volatile hydrocarbons, and vapor concentrations that harm whales would dissipate within several hours after a spill. Within hours after the spill, toxic vapors from oil in a lead could harm the whales' lungs and even kill them, but only a few whales likely would occupy the affected lead at any given time.

IV.C.5.a(1)(c)3) Effects of Ingestion

Bowheads sometimes skim the water surface while feeding, filtering a lot of water for extended periods. If oil were present, they could swallow it. Albert (1981) suggested that whales could take in tarballs or large "blobs" of oil with prey. He also said that swallowed baleen "hairs" mix with the oil and mat together into small balls. These balls could block the stomach at the connecting channel, which is a very narrow tube connecting the stomach's fundic and pyloric chambers (the second and fourth chambers of the stomach) (Tarpley et al., 1987). Hansen (1985; 1992) suggests that cetaceans can metabolize ingested oil, because they have cytochrome p-450 in their livers (Hansen, 1992). The presence of cytochrome p-450 (a protein involved in the enzyme system associated with the metabolism and detoxification of a wide variety of foreign compounds, including components of crude oil) suggests that cetaceans should be able to detoxify oil (Geraci and St. Aubin, 1982, as cited in Hansen, 1992). He also suggests that digestion may break down any oil that adheres to baleen filaments and causes clumping (Hansen, 1985). Observations and stranding records do not reveal whether cetaceans would feed around a fresh oil spill long enough to accumulate a critical dose of oil.

Bowheads may swallow some oil-contaminated prey, but it likely would be only a small part of their food. Some zooplankton eaten by bowheads consume oil particles but apparently can excrete hydrocarbons quickly from their system. Tissue studies by Geraci and St. Aubin (1990) revealed low levels of naphthalene in the livers and blubber of baleen whales. This result suggests that prey have low concentrations in their tissues, or that baleen whales may be able to metabolize and excrete petroleum hydrocarbons.

IV.C.5.a(1)(c)4) Effects of Baleen Fouling

Baleen hairs might be fouled, which would reduce a whale's filtration efficiency. Braithwaite (1983, as cited in Bratton et al., 1993) used a simple system to show a 5-10% decrease in filtration efficiency of bowhead baleen after fouling, which lasted for up to 30 days. The study looked at oil thickness for light (0.5 millimeter) and medium (1.0 millimeter) degrees of fouling and for heavy (10.0 millimeters) fouling. The baleen was placed and tested in a horizontal rather than vertical position. The fouled baleen allowed increased numbers of plankton to slip past the baleen without being caught. Fraker (1984) noted that there was a reduction in filtering efficiency in all cases, but only when the baleen was fouled with 10 millimeters of oil was the change statistically different. We do not know how such a reduction in food caught in the baleen would affect the overall health or feeding efficiency of these whales. Geraci and St. Aubin (1985) found that 70% of the oil adhering to baleen plates was lost within 30 minutes. In 8 of 11 trials, more than 95% of the oil was cleared after 24 hours. The study could not detect any change in resistance to water flowing through baleen after 24 hours. This study tested baleen from fin, sei, humpback, and gray whales. The baleen from these whales is shorter and coarser than that of bowhead whales, whose longer baleen has many hairlike filaments. Information from these two studies suggest that a spill of heavy oil, such as Bunker C, or residual patches of weathered oil, could interfere with feeding efficiency of the fouled plates for several days at least (Geraci and St. Aubin, 1985). Lighter oil should result in less interference with feeding efficiency. Geraci and St. Aubin, (1985) stated that it appeared that the concern for oiled whales (baleen fouling) is becoming less defensible based on the low-level immediate impact in Braithwaite's study and the rate of clearance of oil in this study.

Bowheads most likely would occupy oiled waters for only a short time, and filtration efficiency could return to normal in a matter of hours as oil flushes from the baleen. Repeated baleen fouling over a long time, however, might reduce food intake and blubber deposition, which could harm the bowheads.

IV.C.5.a(1)(c)5) Effects of Reduced Food Source

An oil spill probably would not permanently affect zooplankton, the bowhead's major food source, and any effects are most likely to occur nearshore (Richardson et al., 1987, as cited in Bratton et al., 1993). The amount of zooplankton lost, even in a large oil spill, would be very small compared to what is available on the whales' summer-feeding grounds (Bratton et al., 1993).

IV.C.5.a(1)(c)6) Effects of Displacement from Feeding Areas

We have no observations through western science whether bowheads may be temporarily displaced from an area because of an oil spill or cleanup operations. However, Thomas Brower, Sr. (1980) described the effects on bowhead whales of a 25,000-gallon oil spill at Elson Lagoon (Plover Islands) in 1944. It took approximately 4 years for the oil to disappear. For 4 years after the oil spill, Brower observed that bowhead whales made a wide detour out to sea when passing near Elson Lagoon/Plover Islands during fall migration. Bowhead whales normally moved close to these islands during the fall migration. These observations indicate that some displacement of whales may occur in the unlikely event of a large oil spill, and that the displacement may last for several years. Based on these observations, it also appears that bowhead whales may have some ability to detect an oil spill and avoid surfacing in the oil by detouring around the area of the spill. Potential displacement because of disturbance is discussed in Section III.C.3.

Several investigators have observed various cetaceans in spilled oil, including fin whales, humpback whales, gray whales, dolphins, and pilot whales. They did not avoid slicks but swam through them, apparently showing no reaction to the oil. During the spill of Bunker C and No. 2 fuel oil from the *Regal Sword*, researchers saw humpback and fin whales, and a whale tentatively identified as a right whale, surfacing and even feeding in or near an oil slick off Cape Cod, Massachusetts (Geraci and St. Aubin, 1990). Whales and a large number of white-sided dolphins swam, played, and fed in and near the slicks. The study reported no difference in behavior between cetaceans within the slick and those beyond it. None of the observations prove whether cetaceans can detect oil and avoid it. Some researchers have concluded that baleen whales have such good surface vision that they rely on visual clues for orientation in various activities. In particular, bowhead whales have been seen "playing" with floating logs and sheens of fluorescent dye on the sea surface of the sea (Wursig et al., 1985, as cited in Bratton et al., 1993). These observations suggest that if oil is present on the sea surface and is of such quality or in such quantity that it is readily optically recognizable, bowhead whales may be able to recognize and avoid it (Bratton et al., 1993).

After the *Exxon Valdez* oil spill, researchers studied the potential effects of an oil spill on cetaceans. Dahlheim and Loughlin (1990) documented no effects on the humpback whale. von Ziegesar, Miller, and Dahlheim (1994) found no indication of a change in abundance, calving rates, seasonal residency time of female-calf pairs, or mortality in humpback whales as a result of that spill, although they did see temporary displacement from some areas of Prince William Sound. It was difficult to determine whether the spill changed the number of humpback whales occurring in Prince William Sound. This study could not have detected long-term physiological effects to whales or to the humpback's prey.

IV.C.5.a(1)(c)7) Other Effects and Information

We know of no bowhead whale deaths resulting from an oil spill. Loughlin (1994) did necropsies on three gray whales and one minke whale (which are baleen whales) and three harbor porpoises (which are not baleen whales) after the *Exxon Valdez* oil spill. He found no indication of the cause of death and could not link the cause of death directly to the spill. He observed the carcasses of 26 gray whales, but attributed this large number to the timing of the search effort coinciding with the northern migration of gray whales, augmented by increased survey effort in the study area associated with the oil spill.

Dahlheim and Matkin (1994) observed killer whales near the *Exxon Valdez* oil spill. Before the spill, the AB pod in Prince William Sound had 36 whales. Following the spill, 14 killer whales were missing from the AB pod and presumed dead. Although there was a history of the AB pod interacting with the sablefish fishery in Prince William Sound, there was no evidence of fishery-related mortality in 1988-1990. No whales in distress were seen following the spill, nor were any carcasses found. It is assumed that the whales died. The authors concluded that some of the whales may have died from natural causes and the rest from interactions with fisheries or the spill, or a combination of both. The whales died after and near the spill, but the cause of death is uncertain. There is a spatial and temporal correlation between the loss of whales and the spill, but there is no clear cause-and-effect relationship.

During the oil spill off Santa Barbara in 1969, an estimated 3 million gallons of oil may have entered the marine environment. Gray whales were beginning their annual migration north during the spill. Whales were observed migrating northward through the slick. Several dead whales were observed and carcasses recovered, including six gray whales, one sperm whale, one pilot whale, five common dolphins, one Pacific white-sided dolphin, and two unidentified dolphins. Brownell (1971, as reported by Geraci, 1990) acknowledged that these whales totaled more than the usual number of gray whales and dolphins stranding annually on California shores, and concluded that increased survey efforts had led to the higher counts. Several of the whales examined were thought to have died from natural causes, and one may have been harpooned. No evidence of oil contamination was found on any of the whales examined. The Batelle Memorial Institute concluded the whales were either able to avoid the oil, or were unaffected when in contact with it.

Although there is no conclusive evidence that bowhead whales would be killed as a result of contact with spilled oil, a few whales could die from prolonged exposure to oil.

In the 1980s, there was fairly limited information regarding how heavy metals and other contaminants may affect bowhead whales. Heavy metals and other contaminants, while not specifically associated with oil spills, are of concern to the health of bowhead whales and to humans who use bowhead whales for food. Information about cetacean metabolism also is inadequate. Bratton et al. (1993) measured organic arsenic in the liver tissue of one bowhead whale and found that about 98% of the total arsenic was arsenobetaine. Arsenic in marine biota generally is in an organic form, mostly arsenobetaine, that appears to be nontoxic and of no concern to humans using them as food. Based on the limited data available, researchers (Bratton et al., 1993) concluded that petroleum products appear not to harm bowheads or humans who eat them, but we need more research to be certain. In addition, we provided funds to the National Oceanic and Atmospheric Administration in 1987 to establish and conduct a program for collection and long-term storage of tissues from Alaska marine mammals for future contaminant analysis. This program, the Alaska Marine Mammal Tissue Archival Project, which has been managed by the National Marine Fisheries Service since 1992, contains tissue samples from bowhead whales and other marine mammals. Tissue samples were collected from whales landed at Barrow in 1992. Initial studies of bowhead tissues (Becker et al., 1995) indicate that bowhead whales have very low levels of mercury, PCB's, and chlorinated hydrocarbons, but they have fairly high concentrations of cadmium in their liver and kidneys. Cadmium is a naturally occurring heavy metal that commonly is present at high levels in marine mammal tissues, particularly in the liver and kidney. The study concluded that the high concentration of cadmium in the liver and kidney tissues of bowheads warrants further investigation. Becker (2000) noted that concentration levels of chlorinated hydrocarbons in bowhead whale blubber generally are an order of magnitude less than what has been reported for beluga whales in the Arctic. This probably reflects the difference in the trophic levels of these two species; the bowhead being a baleen whale feeding on copepods and euphausiids, while the beluga whale is a toothed whale feeding at a level higher in the food web. The concentration of total mercury in the liver also is much higher in beluga whales than in bowhead whales.

Bratton et al. (1997) looked at eight metals (arsenic, cadmium, copper, iron, mercury, lead, selenium, and zinc) in the kidneys, liver, muscle, blubber, and visceral fat from bowheads harvested from 1983-1990. These metals were chosen because they are the most common metals reported in the literature for cetaceans, they represent the most toxic metals to marine organisms, and they are the most likely metals to enter the Inupiat diet. They observed considerable variation in tissue metal concentration among the whales tested. Metal concentrations evaluated did not appear to increase over time between 1983 and 1990. Based on metal levels reported in the literature for other baleen whales, the metal levels observed in all tissues of the bowhead are similar to levels in other baleen whales. None of the metals studied were high enough in muscle, blubber, or visceral fat to pose a risk to human consumers. The study concluded the tissues from bowhead whales are, in general, nutritious and safe to eat. The bowhead whale has little metal contamination as compared to other arctic marine mammals, except for cadmium, which requires further investigation as to its role in human and bowhead whale health. The study recommended limiting the consumption of kidney from large bowhead whales pending further evaluation.

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

IV.C.5.a(1)(d) Probabilities of Contacting an Oil Spill

Neff (1990) reports that several studies have tried to model the probability that bowhead whales would contact spilled oil in the Navarin Basin, Chukchi Sea, and Beaufort Sea in the unlikely event of a large oil spill. The models suggest that only a small number of the Beaufort Sea bowhead population would be affected by a large spill. The model by Reed et al. (1987) predicted the greatest number of contacts would occur in the Beaufort Sea, but that no encounter involved more than 1.9% of the population. According to the diving-behavior study, most of the encounters involved fewer than 100 surfacings in oil-covered waters. Bratton et al. (1993), describing an oil-spill model and bowhead whale/oil-spill linkages, indicated one model calculated a total probability of 51.8% that at least one whale would encounter oil spilled in the Beaufort Sea Planning Area, should a spill occur or, alternatively, a 48.2% probability of no whales surfacings in oil. These models used oil-spill probabilities from MMS's 5-year oil and gas lease schedule for 1987-1991 for spills greater than 1,000 barrels. Whether bowhead whales would come into contact with oil would depend on the location, timing, and magnitude of the spill; the presence and extent of shorefast and broken ice; and the effectiveness of cleanup activities.

Geraci and St. Aubin (1990) stated that the notable weakness in modeling is that there is no information on the type and duration of oil exposure required to produce an effect. They further stated that for all but the sea otter, the premise that contact is fatal is indefensible. Models commonly overestimate the impact of a spill. They further stated that few, if any, cetaceans have been claimed by spilled oil.

IV.C.5.a(1)(e) Sale-Specific Probabilities of Contacting an Oil Spill

This section discusses the probabilities that oil spilled in the Beaufort Sea would contact specific environmental resource areas that are important to bowhead whales.

No oil spills are assumed to occur during exploration activities. For the development/production phase, the fate and behavior of a 1,500-barrel spill from a platform and a 4,600-barrel spill from a pipeline are considered in this EIS. The probabilities of either spill contacting specific environmental resource areas would be the same. The 1,500-barrel spill would cover a smaller area (181 square kilometers) (Table IV.A-6a) than the 4,600-barrel spill (320 square kilometers) after 30 days (Table IV.A-6b). Only the 4,600-barrel spill is analyzed in this section. Conditional and combined probabilities also are presented in the following.

A 4,600-barrel spill could contact environmental resource areas where bowhead whales may be present. Approximately 40% of a 4,600-barrel spill during the open-water period would remain after 30 days, covering a discontinuous area of 320 square kilometers (Table IV.A-6b). A spill during broken ice in the fall or under the ice in the winter would melt out during the following summer. Approximately 69% of a 4,600-barrel spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 252 square kilometers (Table IV.A-6b). The following paragraphs present conditional and combined probabilities estimated by the Oil-Spill-Risk Analysis model (expressed as a percent chance) of a spill contacting bowhead whale habitat within 180 days. Conditional probabilities are based on the assumption that a spill has occurred. Combined probabilities, on the other hand, factor in the chance of the spill occurring.

Summer Spill. For conditional probabilities, the Oil-Spill-Risk Analysis model estimates a less than 0.5-37% chance that an oil spill starting at LA1-LA18 will contact ERA's 19-37 within 180 days during the summer, assuming a spill occurs, and a less than 0.5-46% chance, assuming a spill starts at Pipeline Segment (P) P1-P13 (Table A.2-23). The ERA's 19 through 28 are resource areas in the spring lead system in the Beaufort and Chukchi seas; ERA's 29 through 37 are resource areas along the bowhead whale fall-migration route in the Beaufort Sea, as defined by data from the MMS Bowhead Whale Aerial Survey Program. The greatest percent chance of contact from a launch area occurs at ERA 32, which has a 37% chance of contact from a spill occurring at LA10. The chance of contact in this environmental resource area is highest, because the Oil-Spill-Risk Analysis model's launch area and the environmental resource area are in close proximity to or overlap each other (Maps A-2a and 2b). Similarly, the highest chance of contact in other environmental resource areas occurs when the spill-launch area and the environmental resource area are in close proximity to or overlap each other. The greatest percent chance of contact from a pipeline segment occurs at ERA 32, which has a 46% chance of contact from a spill occurring at P4 (Table A.2-23). The chance of contact in this environmental resource area is highest, because the model's pipeline segment and the resource area are in close proximity to or overlap each other (Maps A-2a and 2b). Similarly, the highest chance of contact in other environmental resource areas occurs when the pipeline segment and the resource area are in close proximity to or overlap each other.

Winter Spill. The Oil-Spill-Risk Analysis model estimates a less than 0.5-27% chance that an oil spill starting at LA1-LA18 will contact ERA's 19-37 within 180 days during the winter, assuming a spill occurs, and a less than 0.5-32% chance, assuming a spill starts at P1-P13 (Table A.2-41). The greatest percent chance of contact from a launch area occurs at ERA's 25 and 28, which have a 27% chance of contact from a spill occurring at LA2 and LA7, respectively. The chance of contact in these environmental resource areas is highest, because the model's launch areas and the resource areas are in close proximity to or overlap each other (Maps A-2a and 2b). Similarly, the highest chance of contact in other environmental resource areas occurs when the launch area and the resource area are in close proximity to or overlap each other. The greatest percent chance of contact from a pipeline segment occurs at ERA 25, which has a 32% chance of contact from a spill occurring at P1 (Table A.2-23). The chance of contact in this environmental resource area is highest, because the model's pipeline segment and the resource area are in close proximity to or overlap each other (Maps A-2a and 2b). Similarly, the highest chance of contact in other environmental resource areas occurs when the pipeline segment and the resource area are in close proximity to or overlap each other.

For combined probabilities, the Oil-Spill-Risk Analysis model estimates a less than 0.5-1% chance that one or more oil spills greater than or equal to 1,000 barrels would occur from a production facility or a pipeline (LA1-LA18 or P1-P13, respectively) and contact ERA's 19-37 within 180 days (Table A.2-56). There is a 1% chance that one or more oil spills would occur and contact ERA 28 (Beaufort Spring Lead 10), the resource area with the highest chance of contact.

Summary of Oil-Spill Effects: In the unlikely event of a large oil spill, the probability of oil contacting whales is likely to be considerably less than the probability of oil contacting bowhead habitat. If a spill occurred and contacted bowhead habitat during the fall migration, it is likely that some whales would be contacted by oil. It is unknown what effects an oil spill would have on bowhead whales, but some conclusions can be drawn from studies that have looked at the effects of oil on other cetaceans. Engelhardt (1987) theorized that bowhead whales would be particularly vulnerable to effects from oil spills during their spring migration into arctic waters because of their use of ice edges and leads, where spilled oil tends to accumulate. Several other researchers (Geraci and St. Aubin, 1982; St. Aubin, Stinson, and Geraci, 1984) concluded that exposure to spilled oil is unlikely to have serious direct effects on baleen whales. Other studies (Loughlin, 1994; Dahlheim and Matkin, 1994; Dahlheim and Loughlin, 1990) either documented no effects to cetaceans from spilled oil, or the results of the studies were inconclusive. Geraci (1990) reviewed a number of studies on the physiologic and toxic effects of oil on whales and concluded there was no evidence that oil contamination had been responsible for the death of a cetacean.

Nevertheless, the effects of oil exposure to the bowhead whale population are uncertain, speculative, and controversial.

It is likely that some whales would experience temporary, nonlethal effects, including one or more of the following symptoms:

- oiling their skin, causing irritation
- inhaling hydrocarbon vapors
- ingesting oil-contaminated prey
- fouling of their baleen
- losing their food source
- temporary displacement from some feeding areas

Some whales could die as a result of contact with spilled oil, particularly if there is prolonged exposure to freshly spilled oil, such as in a lead. The extent of the effects would depend on how many whales contacted oil, the duration of contact, and the age/degree of weathering of the spilled oil. The number of whales contacting spilled oil would depend on the location, size, timing, and duration of the spill and the whales' ability or inclination to avoid contact. If oil got into leads or ice-free areas frequented by migrating bowheads, a large portion of the population could be exposed to spilled oil. Under some circumstances, some whales could die as a result of contact with spilled oil. Prolonged exposure to freshly spilled oil could kill some whales, but the number likely would be small.

IV.C.5.a(1)(f) Effectiveness of Mitigating Measures

Several mitigating measures will be considered for the Beaufort Sea sales that may offer some protection to bowhead whales. These include two stipulations, a standard stipulation, Industry Site-Specific Bowhead Whale-Monitoring Program and a new proposed stipulation, Pre-booming Requirements for Fuel Transfers, and the ITL clauses on Endangered Whales and MMS Monitoring Program.

The stipulation on Industry Site-Specific Bowhead Whale-Monitoring Program mandates that lessees will conduct a site-specific monitoring program during exploratory-drilling activities, including seismic activities, to determine when bowhead whales are present in the vicinity of leases and the extent of behavioral effects of these activities on bowhead whales. The stipulation requires a peer review of monitoring plans and the draft report from the monitoring program. If the information obtained from this or other monitoring programs indicates that there is a threat of serious, irreparable, or immediate harm to the species, the lessee will be required to suspend operations causing such threat, which should help to minimize the likelihood of disrupting whale feeding, migration, or socialization. Some endangered whales may interact with the activities associated with exploratory drilling and some inadvertent conflicts or incidental "taking" situations could occur. These inadvertent conflicts with or incidental "taking" situations of some individual whales as a result of exploration-drilling activities would not constitute a threat of harm to the species. This stipulation, in conjunction with the ITL clause on Information on Endangered Whales and MMS Monitoring Program, addresses Conservation Recommendations No. 3 and No. 4 in the May 25, 2001, National Marine Fisheries Service Biological Opinion for the Alaskan Beaufort Sea. This will help protect endangered bowhead whales during their migration from significant adverse effects due to exploratory activities, such as a blockage or delay of the migration.

The stipulation on Pre-booming Requirements for Fuel Transfers is designed to ensure that no fuel spills would occur for 3 weeks prior to or during the bowhead whale migration. This stipulation also could preclude disturbance activities involved with cleanup operations of a fuel spill prior to the migration.

Two other ITL clauses may offer protection of the bowhead whale: Bird and Marine Mammal Protection, which advises lessees of requirements under the Endangered Species Act and Marine Mammal Protection Act and provides guidelines regarding disturbance of marine mammals, and Sensitive Areas to be Considered in Oil-Spill-Contingency Plans, which identifies areas needing protection in the event of an oil spill.

While benefits are gained from these mitigating measures, the overall effects on bowhead whales with these mitigating measures in place is likely to be the same as if the measures were not in place. Overall, the mitigating measures may provide additional protection to whales but would not eliminate all potential effects. The Industry Site-Specific Bowhead Whale-Monitoring Program should be effective in preventing a delay or blockage of the migration but not in preventing incidental take by harassment. Fewer whales may be affected by activities due to these measures or affected to a lesser extent. However, even with the mitigating measures in place, whales still are expected to experience temporary, nonlethal effects as a result of exposure to oil and gas activities, with potential for some mortality if whales are exposed to freshly spilled oil over a prolonged period.

Conclusion on Effects Common to all Alternatives: Bowhead whales exposed to noise-producing activities such as vessel and aircraft traffic, drilling operations, and seismic surveys most likely would experience temporary, nonlethal effects. Some avoidance behavior could persist up to 12 hours. The Industry Site-Specific Bowhead Whale-Monitoring Program should be effective in preventing a delay or blockage of the migration. Any effects from the discharge of muds and cuttings or suspension of sediment in the water column would be primarily localized around the drill rig because of the rapid dilution/deposition of these materials. Effects on the bowheads prey species likely would be negligible. Whales exposed to spilled oil likely would experience temporary, nonlethal effects, although prolonged exposure to freshly spilled oil could kill some whales. The stipulation on Pre-booming Requirements for Fuel Transfers should ensure that no fuel spills would affect bowhead whales during their migration.

IV.C.5.a(2) Effects of Alternatives and Sales

Industry would view leasing, exploration, and development activities in the three proposed sales from an economic and resource perspective. Activities are analyzed over three geographic zones based on water depth and proximity to existing infrastructure (near/shallow, mid-range/medium depth, and far/deepwater) (Map 4). The Near Zone is in the central Beaufort Sea and extends from the Colville River on the west to the Canning River on the east in waters from approximately 0-10 meters. The Midrange Zone includes waters from 10-30 meters deep and extends from Cape Halkett on the west to Barter Island on the east. The Far Zone includes water depths greater than 40 meters and extends from offshore Barrow on the west to the Canadian Border on the east. The MMS expects that leasing and subsequent exploration and development activities will be concentrated in the Near Zone near existing infrastructure for all three sales, with activities expanding into deeper water and more remote areas in subsequent sales (Table IV.A-4).

IV.C.5.a(2)(a) General Information for the Exploration Phase

Exploration drilling in shallow water (5-10 meters) likely would be conducted during the winter from artificial ice islands grounded to the seafloor. Exploration activities are fairly temporary and could be widespread throughout the sale area. Activities in shallow water could occur in the Near, Midrange, or Far zone. Exploration activities will be supported by ice roads over landfast ice. It is unlikely that gravel islands will be constructed to drill exploration wells, although older artificial islands or natural shoals could be used as a base for temporary gravel or ice islands. Most construction activities also would occur during the winter. Bottom-founded platforms could be used to drill in water depths of 10-20 meters. Although the platform would be moved to the drill site during the open-water season and some activity may occur during the bowhead migration, drilling operations likely would be conducted only during the winter. Drill ships supported by icebreakers and supply boats would be used in waters deeper than 20 meters. Construction activities and drilling operations from ice islands, gravel islands, or bottom-founded structures are likely to have negligible effect on bowheads. Transport of the bottom-founded platform is likely to have a low effect on bowhead whales, if the activity continues into the bowhead migration. Drilling operations from drill ships with icebreaker support during the bowhead whale migration are likely to have a low effect on bowhead whales, causing most whales to avoid the area around a drill site, particularly if an icebreaker is actively operating in the area.

IV.C.5.a(2)(b) General Information for the Development Phase

Gravel islands would be the likely platform for production facilities in water depths less than approximately 10 meters, and bottom-founded platforms would be used for production facilities in water depths up to 30 meters. Production from deeper water could be developed by extended-reach wells or by subsea wells. Development and production operations would be more permanent and more localized than exploration activities. Offshore pipelines in water less than 50 meters deep will be trenched to protect against ice damage. Construction could occur either in the summer open-water season or during mid- to late winter, when landfast ice has stabilized.

IV.C.5.a(2)(c) Alternatives

IV.C.5.a(2)(c)1) Effects of Alternative I for Sale 186

The sale-specific effects from noise and disturbance and oil spills from Alternative I for Sale 186 generally would be similar to those discussed in Sections IV.C.5.a(1)(a) and IV.C.5.a(1)(c)). Potential disturbances could result from seismic surveys, drilling operations, vessel and aircraft traffic, and construction activities. Some whales are likely to avoid these noise-producing activities. Assuming an oil spill occurred in bowhead whale habitat while bowheads were present, some whales could experience one or more of the following: skin contact, baleen fouling, respiratory distress caused by inhalation of hydrocarbon vapors (from a fresh spill), localized reduction in food resources, consumption of some contaminated prey items, and perhaps a temporary displacement from some feeding areas. The number of whales contacted would depend on the size, timing, and duration of the spill; the density of the whale population in the area of the spill; and the whales' ability or inclination to avoid contact with oil.

IV.C.5.a(2)c)1)a) Sale-Specific Information for the Exploration Phase

The MMS expects approximately 70% of leasing and exploration activities to occur in the Near Zone, 20% to occur in the Midrange Zone, and 10% in the Far Zone (Table F-1). The MMS expects 12 exploration and delineation wells to be drilled from one or two drilling rigs between 2004 and 2010 during the exploration phase (Table IV.A-4). From one to three wells would be drilled each year. Exploration activities would be supported by an estimated 155 helicopter flights and up to 14 supply-boat trips per year (Table IV.A-4). An estimated 54 square miles of shallow-hazards seismic surveys would be conducted.

IV.C.5.a(2)(c)1)b) Sale-Specific Information for the Development Phase

The MMS expects two development projects to occur in the Near Zone, one in the Midrange Zone, and none in the Far Zone. The MMS expects 69 production wells, 33 injection wells, and approximately 40 miles of offshore pipeline during the development phase (Table IV.A-4). For production, the MMS assumes three new fields, ranging in size from 120-220 million barrels of oil (total production of 460 million barrels), would be discovered as a result of this sale. Development and production activities would be supported by an estimated 300-600 helicopter flights during construction, 28-56 helicopter flights during development, and 12-28 helicopter flights during production (Table IV.A-4). Marine-support traffic for the construction phase may vary from 150-200 supply-boat trips each open-water season for nearshore platforms to as many as 250 for structures beyond the landfast-ice zone. During the production phase, vessel traffic would decline to 4-6 trips per season for nearshore platforms. An estimated 105 square miles of shallow-hazards seismic surveys would be conducted.

IV.C.5.a(2)(c)1)c) Effects from Noise and Disturbance

Most exploration-drilling operations and construction activities in Sale 186 would occur nearshore in shallow water during the winter, although bottom-founded platforms would be moved to the drill site during the open-water season, and some activity may occur during the bowhead migration. Construction activities and drilling operations from ice islands, gravel islands, or bottom-founded structures are likely to have negligible effect on bowheads. Some whales may avoid the area near these activities, if they are conducted during the open-water season. Transport of the bottom-founded platform is likely to have a low effect on bowhead whales, if the activity continues into the bowhead migration. Drilling operations from drill ships with icebreaker support during the bowhead whale migration are likely to have a low effect on bowhead whales, causing most whales to avoid the area around a drill site, particularly if an icebreaker is actively operating in the area.

Overall, geophysical seismic operations in the Beaufort Sea sale area are likely to be relatively limited, because seismic surveys previously have been conducted over much of the area. Any presale seismic surveys conducted likely would be fill-in programs to cover an area not previously surveyed or a 3-dimensional seismic survey to better define a prospect. Seismic surveys associated with exploration and production for Sale 186 would be shallow-hazards surveys conducted over a relatively small area. Much of the seismic surveying in shallow water could be conducted during the winter over the ice. Seismic surveys in deeper waters likely would be conducted during the open-water season and much of it prior to the bowhead whale migration. Seismic surveys in the central Beaufort Sea conducted during the open-water season likely would be limited to areas west of Cross Island after September 1 under the provisions of the Conflict Avoidance Agreement between the operator and subsistence whalers and likely would have negligible effect on bowhead whales. Similar agreements between the operator and subsistence whalers are likely to be established for any seismic surveys proposed near Kaktovik and Barrow. Some whales may avoid seismic operations that are conducted during the whale-migration period. Overall, effects of seismic operations on bowhead whales are likely to range from negligible to low.

The effects of noise from production activities likely would be similar to those from exploration activities. Some whales may avoid the production facility during their migration across the Alaskan Beaufort Sea, depending on the type and location of the facility. Noise from production operations on gravel islands, bottom-founded platforms, and extended-reach wells is not likely to travel far. Whales are more likely to avoid subsea wells, because these may be in deeper water and farther from shore. The overall effect on bowheads from this avoidance behavior is likely to be negligible.

Overall, the effects of noise on bowhead whales and the bowhead whale population from exploration and development/production activities from Alternative I for Sale 186 generally would be similar to those discussed in Section IV.C.5.a(1), because the activities expected to occur are likely to be similar. The effects from an encounter with aircraft generally are brief, and the whales should resume their normal activities within minutes. Bowheads may exhibit temporary avoidance behavior to vessels at a distance of 1-4 kilometers. Most bowhead whales during the fall migration are likely to avoid an area around a seismic vessel operating in nearshore waters by a radius of up to 20 kilometers. Avoidance may persist up to 12 hours after the end of seismic operations. Some bowheads may avoid drilling noise at 20 kilometers or more. Overall, bowhead whales exposed to noise-producing activities most likely would experience temporary, nonlethal effects.

IV.C.5.a(2)(c)1)d) Effects from an Oil Spill

No oil spills are assumed to occur during exploration activities. Development/production activities for Sale 186 are not expected to occur in the Far Zone; therefore, there would be no spill from launch areas or pipeline segments in this zone (LA1-LA6, LA11, LA13, LA14, LA16, LA18, P1, P2, P5, P6, P8, and P11). As a result, the Oil-Spill-Risk Analysis model’s conditional probabilities for Sale 186 would be same as or slightly less for some environmental resource areas than those presented in Section IV.C.5, which discusses conditional probabilities for all launch areas and pipeline segments in the Beaufort multiple-sale area.

Summer Spill. Under Sale 186, the Oil-Spill-Risk Analysis model estimates a chance less than or equal to.5-37% that an oil spill will contact ERA’s 19-37 within 180 days during the summer, assuming a spill occurs at LA7-LA10, LA12, and LA17 (Table A.2-23). There is a less than or equal to.5-46% chance, assuming an oil spill occurs at P3, P4, P7, P9, P10, P12, and P13. The greatest percent chance of contact occurs at ERA 32 (Ice/Sea Segment 4), which has a 37% chance of contact from a spill occurring at LA10 and a 46% chance of contact from a spill occurring at P4, the same as described in Section IV.C.5.a(1)(c)).

Winter Spill. The Oil-Spill-Risk Analysis model estimates a chance less than or equal to.5-27% chance that an oil spill will contact ERA’s 19-37 within 180 days during the winter, assuming a spill occurs at LA7-LA10, LA12, and LA17 (Table A.2-41). There is a chance less than or equal to .5-23% assuming an oil spill occurs at P3, P4, P7, P9, P10, P12, and P13 (Table A.2-41). The greatest percent chance of contact occurs at ERA 28 (Beaufort Spring Lead 10), which has a 27% chance of contact from a spill occurring at LA7 and a 23% chance of contact from a spill occurring at P3.

For combined probabilities, the model estimates a chance less than or equal to 0.5-1% that one or more large oil spills would occur from a production facility or a pipeline and contact ERA’s 19-37 within 180 days (Table A.2-56), the same as those presented in Section IV.C.5.a(1)(c)). There is a 1% chance that one or more large oil spills would occur and contact ERA 28 (Beaufort Spring Lead 10), the environmental resource area with the highest chance of contact. Combined probabilities are the same for all sales and for all alternatives.

Overall, the effects of an oil spill on bowhead whales and the bowhead whale population from exploration and development/production activities from Alternative I for Sale 186 generally are expected to be similar to those discussed in Section IV.C.5.a(1)(c)). In the unlikely event of a large oil spill, the probability of oil actually contacting whales would be considerably less than the probability of contact with bowhead habitat.

In the unlikely event of a large uncontrolled, uncontained spill, a few bowheads could experience one or more of the following: skin contact with oil, baleen fouling, inhalation of hydrocarbon vapors, a localized reduction in food resources, the consumption of oil-contaminated prey items, and perhaps temporary displacement from some feeding areas. Some individuals may be killed or injured as a result of prolonged exposure to freshly spilled oil; however, the number of individuals so affected is expected to be small. Exposure of bowhead whales to spilled oil may result in lethal effects to a few individuals, although most individuals exposed to spilled oil likely would experience temporary, nonlethal effects.

Conclusion: The sale-specific effects of noise, disturbance, and oil spills on bowhead whales and the bowhead whale population from exploration and development/production activities in Alternative I for Sale 186 generally are expected to be similar to those discussed in Sections IV.C.5.a(1) and IV.C.5.a(1)(c), because the activities expected to occur are likely to be similar. Overall, leasing, exploration, and production activities associated with Alternative I for Sale 186 likely would have minimal effect on bowhead whales. The effects from an encounter with aircraft generally are brief, and the whales should resume their normal activities within minutes. Bowheads may exhibit temporary avoidance behavior to vessels at a distance of 1-4 kilometers, including the transport of bottom-founded drilling platforms. Most bowhead whales during the fall migration are likely to avoid an area around a seismic vessel operating in nearshore waters by a radius of up to 20 kilometers. Avoidance may persist up to 12 hours after the end of seismic operations. In addition, provisions under the Conflict Avoidance Agreement that are likely to be implemented during the bowhead whale migration place limitations on where and when seismic operations can be conducted. Some bowheads may avoid drilling noise at 20 kilometers or more. Drilling operations from drill ships with icebreaker support during the bowhead whale migration are likely to have a low effect on bowhead whales, causing most whales to avoid the area around a drill site, particularly if an icebreaker is actively managing ice in the area. Overall, bowhead whales exposed to noise-producing activities most likely would experience temporary, nonlethal effects.

The Oil-Spill-Risk Analysis model conditional probabilities for Alternative I for Sale 186 would be less for some environmental resource areas than those presented in Section IV.C.5.a(1), because no development activity is expected in the Far Zone. In the unlikely event of a large oil spill, some individuals may be killed or injured as a result of prolonged exposure to freshly spilled oil; however, the number of individuals affected likely would be small. Some bowheads could experience skin contact with oil, baleen fouling, inhalation of hydrocarbon vapors, a localized reduction in food resources, the consumption of oil-contaminated prey items, and/or perhaps temporary displacement from some feeding areas. Exposure of bowhead whales to spilled oil may result in lethal effects to a few individuals, although most individuals exposed to spilled oil likely would experience temporary, nonlethal effects.

IV.C.5.a(2)(c)2) Effects of Alternative I for Sale 195

The sale-specific effects for Alternative I for Sale 195 generally would be similar to those discussed in Section IV.C.5 and in Effects of Alternative I for Sale 186. Three new fields ranging in size from 120-220 million barrels are expected, with total production remaining at 460 million barrels. The number of wells drilled and level of support activities likely would be essentially the same as for Sale 186.

IV.C.5.a(2)(c)2)a) Differences between Alternative I for Sale 195 and Sale 186

Sale 195 would have the following differences from Sale 186:

- 50% of leasing and exploration activities in the Near Zone as compared to 70%
- 30% in the Midrange Zone as compared to 20%
- 20% in the Far Zone as compared to 10%
- one development project in the Near/Shallow Zone as compared to two

IV.C.5.a(2)(c)2)b) Effects from Noise and Disturbance

Seismic surveys, drilling operations, vessel and air traffic, and construction activities could cause noise and disturbance to bowhead whales during exploration and development/production activities. The effects of noise on bowheads from Sale 195 likely would be similar to those described in Section IV.C.5.a(1), because the activities expected to occur are likely to be similar.

IV.C.5.a(2)(c)2c) Effects from an Oil Spill

No oil spills are assumed to occur during exploration activities. There would be no spill from launch areas or pipeline segments in the Far Zone (LA1-LA6, LA11, LA13, LA14, LA16, LA18, P1, P2, P5, P6, P8, and P11), because no development activities are expected in the Far Zone. The Oil-Spill-Risk Analysis model conditional probabilities for Sale 195 would be the same as or slightly less for some environmental resource areas than those presented in Section IV.C.5.a(1)(c)). Sale-specific effects generally are expected to be similar to those presented in Section IV.C.5.a(1)(c) and essentially the same as described in Effects of Alternative I for Sale 186.

Conclusion: The effects of exploration and production activities on bowhead whales are likely to be similar to those described in Sections IV.C.5.a(1) and IV.C.5.a(1)(c) and in Effects of Alternative I for Sale 186, because the activities expected to occur are likely to be similar. Although more activities likely would occur in deeper waters, the differences in effects to bowhead whales between Sales 186 and 195 probably are not measurable.

IV.C.5.a(2)(c)3) Effects of Alternative I for Sale 202

The sale-specific effects of Alternative I for Sale 202 generally are expected to be similar to those discussed in Sections IV.C.5.a(1) and IV.C.5.a(1)(c). One new field ranging in size from 120-220 million barrels is expected, with total production remaining at 460 million barrels. The number of wells drilled and level of support activities likely would be slightly less than for Sale 186.

IV.C.5.a(2)(c)3a) Differences between Alternative I for Sale 202 and Sale 186

Sale 202 would have the following differences from Sale 186:
- 40% of leasing and exploration activities in the Near Zone as compared to 70%
- 30% in the Midrange Zone as compared to 20%
- 30% in the Far Zone as compared to 10%
- One fewer exploration/delineation well
- One fewer platform and one fewer production well
- One more injection well
- 5 miles of offshore pipeline
- 140 helicopter support flights as compared to 155
- 7 supply boat trips as compared to 14

IV.C.5.a(2)(c)3b) Effects from Noise and Disturbance

Seismic surveys, drilling operations, vessel and air traffic, and construction activities could cause noise and disturbance to bowhead whales during exploration and development/production activities. The effects of noise on bowheads from Sale 202 likely would be similar to those described in Section IV.C.5.a(1), because the activities expected to occur are likely to be similar.

IV.C.5.a(2)(c)3c) Effects from an Oil Spill

No oil spills are assumed to occur during exploration activities. One development/production project is expected to occur in the Far Zone for Sale 202. There would be no spill from LA8 and LA10, because no development/production projects are expected in the Near or Midrange zones. The Oil-Spill-Risk Analysis model conditional probabilities for Sale 202 would be the same as or slightly less for some environmental resource areas than those presented in Section IV.C.5.a(1)(c). Sale-specific effects of Alternative I for Sale 202 generally are expected to be similar to those discussed in Section IV.C.5.a(1)(c).

Summer Spill. The Oil-Spill-Risk Assessment model estimates a chance less than or equal to 0.5-36% that an oil spill will contact ERA's 19-37 within 180 days during the summer, assuming a spill occurs at LA1-LA7, LA9, and LA11-LA18 (Table A.2-23). There is a chance less than or equal to 0.5-46% assuming an oil spill occurs at P1-P13. The greatest percent chance of contact occurs at ERA 34 (Ice/Sea Segment 6), which has a 36% chance of contact from a spill occurring at LA15 and at ERA 32 (Ice/Sea Segment 4), which has a 46% chance of contact from a spill occurring at P4, respectively. These probabilities are similar to those presented in Section IV.C.5.a(1)(c).

Winter Spill. The model estimates a estimates a chance less than or equal to 0.5-27% that an oil spill will contact ERA's 19-37 within 180 days during the winter, assuming a spill occurs at LA1-LA7, LA9, and LA11-LA18 (Table A.2-41). There is a chance less than or equal to 0.5-32% assuming an oil spill occurs at pipeline segments P1-P13 (Table A.2-41). The greatest percent chance of contact occurs at ERA's 25 and 28 (Beaufort Spring Lead 7 and 10), which have a 27% chance of contact from a spill occurring at LA2 and LA7, respectively. There is a 32% chance of contact to ERA 25 from a spill occurring at P1.

Conclusion: The effects of exploration and production activities on bowhead whales for this sale are likely to be similar to those described in Sections IV.C.5.a(1) and IV.C.5.a(1)(c), because the activities expected to occur are likely to be similar. Although more activities likely would occur in deeper waters than in Sale 186 and Sale 195, the differences in effects to bowhead whales between Sale 202 and Sales 186 and 195 probably are not measurable.

IV.A.5.a(2)(c)4) Effects of Alternatives III through VI for Sale 186 and Sale 195

Alternatives III (Barrow Subsistence Whaling Deferral), IV (Nuiqsut Subsistence Whaling Deferral), VII (Kaktovik Subsistence Whaling Deferral), and VI (Eastern Deferral) are essentially the same for each sale. These alternatives are not likely to reduce noise or oil-spill effects to bowhead whales as compared to Alternative I for Sale 186 and Sale 195. Any differences in effects on bowheads between these deferrals and Alternative I likely be difficult to measure. These deferrals include only areas in the Far Zone. Under Sale 186, 10% of the leasing and exploration activities and no development activities likely would occur in the Far Zone. An estimated 90% of leasing and exploration activities and all of the development activities likely would occur in the Near and Midrange zones. Under Sale 195, 20% of the leasing and exploration activities likely would occur in the Far Zone. Exploration activities that might have occurred in the Far Zone in these deferral areas would be excluded under these alternatives.

The effects of noise on bowhead whales are likely to be essentially the same as described in Section IV.C.5 and in Effects of Alternative I for Sales 186 and 195. It is likely that exploration activities in the Far Zone, if any, would be limited. No development activities are likely to occur. Differences in noise effects to bowhead whales from these deferral alternatives as compared to Alternative I are not likely to be measurable.

The effects of an oil spill on bowhead whales likely would be similar to that described in Section IV.C.5.a(1)(c). For conditional probabilities, the same launch areas and pipeline segments excluded in Alternative I for Sales 186 and 195 would be excluded under these deferrals. Environmental resource areas likely to be contacted by spilled oil and the probabilities of contact would be essentially the same for conditional probabilities as described in Alternative I. The differences in oil-spill effects to bowhead whales from these deferrals compared to Alternative I likely would be difficult to measure.

Conclusion: The effects of noise and oil spills on bowhead whales are likely to be essentially the same as described in Sections IV.C.5.a(1) and IV.C.5.a(1)(c)) and in Effects of Alternative I for Sale 186 and 195, because the activities expected to occur are likely to be similar.

Differences in noise and oil-spill effects to bowhead whales from these deferrals compared to Alternative I likely would be difficult to measure.

IV.C.5.a(2)(c)5) Effects of Alternative IV for Sales 186 and 195

Alternatives IV (Nuiqsut Subsistence-Whaling Deferral) are essentially the same for each sale. This alternative could reduce noise and oil-spill effects to bowhead whales somewhat as compared to Alternative I under for Sales 186 and Sale 195. However, any differences in effects between this deferral and Alternative I likely would be difficult to measure. This deferral includes only areas in the Near and Midrange zones. Under Sale 186, 70% of the leasing and exploration activities likely would occur in the Near Zone and 20% likely would occur in the Midrange Zone under this sale. Under Sale 195, 50% of the leasing and exploration activities likely would occur in the Near Zone and 30% in the Midrange Zone. Although much of the exploration activity in this zone is likely to occur inside the barrier islands, some activity also is likely to be conducted outside the barrier islands. Much of the exploration activity likely would occur during the winter, when bowhead whales are not present. It is expected that two development activities would occur in the Near Zone and one in the Midrange Zone under this sale. The opportunity index for the Nuiqsut Subsistence Whaling Deferral shows a 5% chance that all 460 million barrels of oil resources expected for this sale would be discovered and developed in this area. There is a 95% chance that all 460 million barrels would be discovered outside this deferral area.

Exploration and development activities that might have occurred in this deferral area will be excluded. It is likely that some exploration and development activities would occur in these areas without the deferrals. Exploration and development activities that occur outside the barrier islands during the bowhead whale fall migration could affect the whales. The effects of noise on bowhead whales is likely to be similar to those described in Section IV.C.5 and in Effects of Alternative I under for Sales 186 and Sale 195. Differences in noise effects to bowhead whales from these deferral alternatives as compared to Alternative I are not likely to be measurable.

The effects of an oil spill on bowhead whales likely would be similar to those described in Section IV.C.5.a(1)(c) and in Effects of Alternative I under for Sales 186 and Sale 195. For conditional probabilities, the same launch areas and pipeline segments that were excluded in Alternative I under for Sale 186 would be excluded under these deferrals. Environmental resource areas likely to be contacted by spilled oil and the probabilities of contact would be essentially the same for conditional probabilities as described in Effects of Alternative I under for Sales 186 and Sale 195. The differences in oil-spill effects to bowhead whales from these deferrals compared to Alternative I likely would be difficult to measure.

Conclusion: The effects of noise and oil spills on bowhead whales are likely to be essentially the same as described in Sections IV.C.5.a(1) and IV.C.5.a(1)(c) and in Effects of Alternative I under for Sales 186 and Sale 195 because the activities expected to occur are likely to be similar. The differences in noise and oil-spill effects to bowhead whales from these deferrals compared to Alternative I likely would be difficult to measure.

IV.C.5.a(2)(c)6) Effects of Alternatives III, V, and VI for Sale 202

Alternatives III (Barrow Subsistence Whaling Deferral), V (Kaktovik Subsistence Whaling Deferral), and VI (Eastern Deferral) likely would have similar noise and oil-spill effects to bowhead whales as that described in Alternative I for Sale 202. Any differences in effects on bowheads between these deferrals and Alternative I likely would be difficult to measure. These deferrals include primarily areas in the Far Zone. An estimated 40% of the leasing and exploration activities likely would occur in the Near Zone, 30% likely would occur in the Midrange Zone, and 30% likely would occur in the Far Zone under this sale. Much of the exploration activity likely would occur during the open-water season. No development activities likely would occur in the Near or Midrange zones under this sale.

The opportunity index for the Barrow Subsistence Whaling Deferral, the Kaktovik Subsistence Whaling Deferral, and the Eastern Deferral (Table II.A.3) shows a 1%, 3%, and 3% chance, respectively, that all 460 million barrels of oil resources expected for this sale would be discovered and developed in these areas. However, there is a 99%, 97%, and 97% chance, respectively, that all 460 million barrels would be discovered outside these deferral areas.

Exploration and development activities that might have occurred in these deferral areas will be excluded. However, it is likely that no exploration and development activities would occur in these areas without the deferral alternative because of the relatively low probability of discovering oil. The effects of noise on bowhead whales is likely to be similar to those described in Section IV.C.5.a(1)(a) and in Effects of Alternative I for Sale 202, because the activities expected to occur are likely to be similar. The differences in noise effects to bowhead whales from these deferral alternatives as compared to Alternative I are not likely to be measurable.

The effects of an oil spill on bowhead whales likely would be similar to that described in Section IV.C.5.a(1)(c) and in Alternative I for Sale 202. For conditional probabilities, the same launch areas and pipeline segments that were excluded in Alternative I for Sale 202 would be excluded under these deferrals. In addition, LA18 would be excluded. The environmental resource areas likely to be contacted by spilled oil and the probabilities of contact to individual resource areas would be essentially the same for conditional probabilities as described in Effects of Alternative I for Sale 202. The differences in oil spill effects to bowhead whales from these deferrals compared to Alternative I likely would be difficult to measure.

Conclusion: The effects of noise and oil spills on bowhead whales are likely to be similar to that described in Sections IV.C.5.a(1) and IV.C.5.a(1)(c) and in Effects of Alternative I for Sale 202, because the activities expected to occur are likely to be similar. The differences in noise and oil-spill effects to bowhead whales from this deferral as compared to Alternative I likely would be difficult to measure.

IV.C.5.a(2)(c)7) Effects of Alternative IV for Sale 202

Alternative IV (Nuiqsut Subsistence Whaling Deferral) likely would have similar noise and oil-spill effects on bowheads as that described in Alternative I for Sale 202. This deferral includes mostly areas in the Near and Midrange zones and would affect primarily exploration activities. An estimated 40% of the leasing and exploration activities likely would occur in the Near Zone and 30% likely would occur in the Midrange Zone under this sale. No development activities likely would occur in the Near or Midrange zones under this sale. Although much of the exploration activity is likely to occur inside the barrier islands, some activity also is likely to be conducted outside the barrier islands. Much of the exploration activity would likely occur during the winter, when bowhead whales are not present.

Exploration activities that might have occurred in these deferral areas will be excluded. It is likely that some exploration activities would occur in these areas without the deferral. The deferral should have little effect on development/production activities, because these likely would occur in the Far Zone. Exploration activities that occur outside the barrier islands during the bowhead whale fall migration could affect the whales. The effects of noise on bowhead whales is likely to be similar to that described in Section IV.C.5 and in Effects of Alternative I for Sale 202, because the activities expected to occur are likely to be similar. The differences in noise effects to bowhead whales from this deferral alternative as compared to Alternative I are not likely to be measurable.

The effects of an oil spill on bowhead whales likely would be similar to that described in Section IV.C.5.a(1)(c) and in Alternative I for Sale 202. For conditional probabilities, the same launch areas and pipeline segments that were excluded in Alternative I for Sale 202 would be excluded under this deferral. The environmental resource areas likely to be contacted by spilled oil and the probabilities of contact to individual resource areas would be essentially the same for conditional probabilities as described in Effects of Alternative I for Sale 202. The differences in oil spill effects to bowhead whales from these deferrals as compared to Alternative I likely would be difficult to measure.

Conclusion: The effects of noise and oil spills on bowhead whales are likely to be similar to that described in Sections IV.C.5.a(1) and IV.C.5.a(1)(c) and in Effects of Alternative I for Sale 202, because the activities expected to occur are likely to be similar. Although noise and oil-spill effects in the deferral areas would be reduced, there likely would be little change in the overall effects of noise and oil spills on bowhead whales. The differences in noise and oil spill effects to bowhead whales from these deferrals as compared to Alternative I would likely be difficult to measure.

IV.C.5.b. Spectacled Eider

IV.C.5.b(1) Effects Common to All Alternatives

Seasonal distribution of spectacled eiders in the Beaufort Sea region determines their vulnerability to potentially adverse factors associated with oil and gas exploration and development to a large extent. Most spectacled eiders migrating north in spring apparently arrive at Arctic Coastal Plain breeding areas via overland routes from the Chukchi Sea (Troy Ecological Research Assocs., 1999). A major proportion (one-half to two-thirds) of those breeding on the Arctic Coastal Plain nest west of the longitude of Point Barrow; these individuals might not use the Beaufort Sea at all, moving overland to and from the Chukchi Sea. Along the Beaufort coast, most nests are within about 25 kilometers of marine waters, primarily west from the Sagavanirktok River (Troy Ecological Research Assocs., 1997).

After breeding, many males apparently either make little use of the Beaufort Sea prior to their migration west and south as dispersed flocks along the coast (median distance offshore = 6.6 kilometers; Petersen, Larned, and Douglas, 1999) or migrate overland directly to the Chukchi Sea. Others have remained in the Beaufort Sea for more than a week (Troy Ecological Research Assocs., 1999). Most females that have nested in the eastern portion of the range apparently migrate west through the Beaufort Sea to the Chukchi Sea, spending about three times as long as males in the Beaufort Sea. Females with young typically are found farther offshore (median distance offshore = 16.5 kilometers) than males as a result of migrating later when the ice usually is farther offshore (Map 9a). Apparently little use is made of marine habitats in the vicinity of Prudhoe Bay by either sex. Aerial surveys in the central Beaufort Sea suggest that spectacled eiders would be present offshore in low numbers during staging and fall migration periods (Fischer, Tiplady, and Larned, 2002; Stehn and Platte, 2000).

IV.C.5.b(1)(a) Effects of Exploration

IV.C.5.b(1)(a)1) Effects from Routine Operations

IV.C.5.b(1)(a)1)a) Effects of Aircraft/Vessel Disturbance

Spectacled eiders staging or migrating in offshore waters are not likely to experience significant disruption of foraging or other activities or displacement as a result of routine exploration, development, or production activities, primarily helicopter flights (10-20 flights/day during construction; 0.5-1/day during production, Table IV.A-4) during the open-water season. This is because over most of the lease area, there is a low probability that the few areas occupied by scattered flocks during the spring to fall staging and migration periods (males, early June-early July; females, early June-September) would be overflown routinely by support aircraft flying between a few offshore drill sites (for example, a maximum of three sites for Sale 186) and onshore facilities. However, eiders occurring in coastal or offshore portions of the Near Zone or western Midrange Zone areas (Maps 4 and 9a) that are relatively close to primary support facilities at Deadhorse and vicinity are much more likely to be overflown than those in the more distant or eastern portions of the lease area (eastern Midrange and Far zones). This could occur when flight paths from a few scattered offshore drilling sites converge in the air space over waters in the vicinity of support areas such that a greater proportion of this area would be overflown than areas east of Prudhoe Bay or farther offshore. Apparently, however, few eiders remain for long in marine waters in the immediate vicinity of Prudhoe Bay (Troy Ecological Research Assocs., 1996, 1999).

Aerial surveys in the central Beaufort area by the Fish and Wildlife Service in 1999 and 2000 estimated that 166-371 spectacled eiders (about 1 individual/10 square kilometers; Map 9) could have occurred in the area that includes the Near and western Midrange zones (Stehn and Platte, 2000). However, flight paths of eider flocks (average size about 21 individuals during Fish and Wildlife Service surveys) could be intersected by helicopters (disturbance corridor about 2 kilometers or 1.2 miles wide) and cause short-term disturbance effects. Thus, displacement of spectacled eiders is likely to occur only in the vicinity of these narrow but frequently used helicopter flight corridors in offshore areas, or in coastal areas where aircraft flight paths converge near primary support facilities. The convergence effect will be more intense for Sale 186, with two development sites in the Near Zone, one in the Midrange Zone, and none in the Far Zone (Appendix B, Table B-1), than Sale 195 (1, 1, 0) or Sale 202 (0, 0, 1).

Periodic disturbance is not likely to increase mortality significantly, but a small portion of the population may experience increased stress and somewhat lowered fitness if they are displaced routinely from favored foraging sites, especially soon after arrival from southern overwintering areas when there is limited access to ice-free foraging areas. This could cause depletion of stored energy during the critical migration and staging periods when energy requirements are high. However, bottom-survey video records indicate that alternative foraging habitat, similar in appearance and with similar prey organisms present, is widely distributed in the region (LGL Ecological Research Assocs., Inc., 1998). The net result of decreased energy availability may be somewhat lower survival and/or productivity. This is likely to increase the rate of decline, at least for some interval, and the overall length of time required for recovery to former population levels, which will not occur while the population is decreasing. However, in the absence of specific information bearing on this question, it is reasonable to assume that any additional mortality occurring as a result of oil and gas development could increase not only the rate of decline (currently nonsignificant), at least temporarily, but it also would delay the point (i.e., extend the time to status reversal) at which the population could enter a recovery mode (population decline reversed). Also, if additional mortality steepens the rate of decline, the population presumably would decrease to a lower level over a given interval. Thus, it should take the population longer to recover to a specified former level (i.e., delay recovery) at a given rate of increase. Because of the time lapse between sales, no significant overall effect is likely to result from these minor adverse effects associated with each individual sale or all three collectively. Any disturbance could be considered a "take" under the Endangered Species Act.

Because nest sites are scattered at low density over much of the Arctic Coastal Plain, relatively few nesting eiders are likely to be overflown by helicopters from offshore units, and substantial disturbance of nesting or broodrearing eiders is not likely to occur.

IV.C.5.b(1)(a)1)b) Effects of Construction Disturbance

Offshore drill site and pipeline construction that occurs during summer and fall may displace foraging eiders from the local area (within about 1 kilometer); however, such short-term and localized disturbances are not likely to cause significant population effects. Likewise, localized burial of potential prey and destruction of a few square kilometers of foraging habitat as a result of pipeline trenching, island construction, or rig placement is not likely to cause a significant decline in prey availability for eiders. Because few eiders would be likely to occur in these relatively small areas (representing much less than 1% of comparable habitat available in the proposed lease sale area), they are not likely to experience substantial adverse effects from routine construction activities. However, eiders or their foraging areas occurring closer to Prudhoe Bay (i.e., the Near Zone, Map 4) are more likely to be disturbed than those in the more distant portions of the lease sale area, because exploration and development structures and activities are likely to be more concentrated there due to its proximity to this primary support area.

Onshore, because nest sites are scattered at low density over much of the Arctic Coastal Plain, relatively few are likely to become unavailable through burial by pad or road construction or by location in areas of gravel extraction. Only small numbers of nesting eiders are likely to be displaced away from the vicinity of onshore pipeline corridors by construction activity, vehicle traffic, and disturbance by helicopters conducting pipeline inspections. Although pipeline burial would result in permanent removal of habitat, routine disturbance effects would persist only over the life of the field (potentially up to 28 years), and they would be localized primarily within about a kilometer of the pipeline. Positive effects may be realized from water impoundments and early-season food-plant growth in dust shadows along pipeline roads. Net habitat loss and disturbance effects on spectacled eider productivity are not likely to be significant, but recovery of the regional population from even minor adverse effects would not occur while it is in a declining status (currently nonsignificant).

IV.C.5.b(1)(a)1)c) Effects of Collisions with Structures

Because eiders typically fly at a relatively low altitude over water (Johnson and Richardson, 1982), the potential exists for these sea ducks to collide with offshore structures that protrude above the surface. This would be true especially under conditions of poor visibility (for example, fog or darkness) and may be compounded by the potentially attracting or disorienting effect of lights on the structures at night. The lack of information on routes followed by spectacled eiders during migration and other activities in the Beaufort Sea, and specific behavior near and vulnerability to obstructions during migration, makes it difficult to estimate potential mortality. Regarding the potential problems caused by structure lighting, under the terms of the Beaufort Sea Planning Area lease sale EIS Biological Opinion prepared by the Fish and Wildlife Service (USDOI, Fish and Wildlife Service, 2002), the MMS and the Fish and Wildlife Service will cooperate to coordinate development of lighting systems for offshore structures that may reduce the likelihood of bird collisions with such structures.

Although collision of an eider flock (average size ≅ 21 individuals) with an artificial island or drill structure could result in substantial mortality, such structures actually will be relatively small obstructions in the Beaufort Sea, very likely few in number (three or fewer; Appendix F, Table F-3), and most eiders are likely to see and avoid them when visibility is good. However, recent (late September/October 2001) bird fatalities at the currently operational Northstar Island (no spectacled eiders involved) apparently occurred equally during periods with good visibility conditions (although some of these may have occurred at night) and foggy conditions (Taylor, 2001, pers. commun.). In 2001, 20 sea ducks were recovered after colliding with the Northstar facility infrastructure and 16 at Endicott—no spectacled eiders were included. Because the typical spectacled eider density in the Beaufort Sea during most of the period they are present is expected to be relatively low; eider mortality from collisions with islands or drilling structures also is likely to be low. However, during fall migration, some members of flocks (of currently unknown size) of spectacled eiders could be involved in collisions. The risk is likely to be greater in areas closer to and particularly west of Prudhoe Bay (i.e., the Near Zone, Map 4), where structures are likely to be more concentrated because of their proximity to primary support facilities, rather than in the more distant portions of the lease area where development is less likely to occur.

Collision of nesting eiders with the elevated onshore portion of pipelines is considered unlikely, because the nests are likely to be at a very low density near a pipeline, and most of their activities would involve walking or swimming rather than flying. Arriving spring migrants or departing males and unsuccessful females flying to the marine environment could strike onshore pipelines or other structures. Overall, mortality from onshore collisions is likely to be low.

IV.B.5.b(1)(a)1)d) Effects of Discharges

Discharges from drilling operations during exploration or development typically disperse rapidly in the surrounding water, although some may be deposited on the bottom near drill sites. Because the little available survey data from the Beaufort Sea area suggest that eiders apparently occur in low numbers and as dispersed flocks in the Beaufort after breeding, although flocks may occur more frequently in some local areas such as Harrison Bay, relatively few individuals are expected to occur in most local drill-site areas or rely specifically on prey affected or buried in such areas. Thus, discharges are not likely to cause significant effects either through direct contact with birds or by affecting prey availability as a result of the three sales individually or all three collectively due to the insignificance of any additive effects. Drilling structures, the source of most discharges, are expected to be quite dispersed, with just two in the Near Zone, one in the Midrange Zone, and none in the Far Zone for Sale 186 (Sale 195-1, 1, and 0; Sale 202-0, 0, and 1). The minor effects that may result from each sale are not likely to substantially elevate the current nonsignificant rate of decline. For similar reasons, new pipeline construction (estimated to be 0 miles for Sale 186, 40 miles for Sale 195, and 35 miles for Sale 202) is not likely to cause significant effects. Low spectacled eider use of marine waters near Prudhoe Bay suggests a low potential for adverse effects where the most intense and earliest development is expected to occur.

IV.C.5.b(1)(b) Effects of Development and Production

IV.C.5.b(1)(b)1) Effects from Routine Operations

Effects from routine operations during development and production are likely to be the same as those previously discussed under exploration.

IV.C.5.b(1)(b)2) Effects of an Oil Spill

IV.C.5.b(1)(b)2)a) Effects of Disturbance from Oil-Spill Cleanup

In the unlikely event a large oil spill occurs, the presence of substantial numbers of workers, boats, and aircraft activity between the site and support facilities is likely to displace eiders foraging in affected offshore or nearshore habitats during open-water periods for one to several seasons. Disturbance during the initial season, possibly lasting 6 months, is likely to be frequent. Cleanup in coastal areas late in the breeding season may disturb broodrearing, juvenile, or staging eiders (Map 9a). However, staging or migrating flocks generally are dispersed and, thus, would not necessarily occur or stay in the vicinity of the cleanup activity, particularly that occurring on barrier islands. As a result, relatively few flocks are likely to be displaced from favored habitats and expend energy stores accumulated for migration. Predators may take some eggs or young while females are displaced off their nests if located near a site of operation. Survival and fitness of individuals may be affected to some extent, but this infrequent disturbance is not likely to result in significant population losses.

IV.C.5.b(1)(b)2)b) Effects of a Large Oil Spill

Spectacled eiders experiencing moderate or heavy oil contact will not survive; most lightly oiled birds also are not likely to survive at arctic water temperatures. Swallowed oil may cause reduced physiological function and production of fewer young (USDOI, MMS, 1996a; also see USDOI, MMS, Alaska OCS Region, 2002a:Section III.C.2 for details).

IV.C.5.b(1)(b)2)c) Vulnerability of Eiders to Oil Spills

In the unlikely event a large spill occurs during summer or fall periods when staging and migrating eiders occupy open-water marine habitats, a highly variable proportion of the Arctic Coastal Plain population could be vulnerable to oil in the Beaufort Sea, primarily west of the Sagavanirktok River. The probability of contact is lowered by individuals being concentrated in relatively few scattered flocks during the brief period present (Stehn and Platte, 2000:Table 1); however, some flocks may be relatively large (averaging ≅ 21 birds), and contact could result in substantial losses. The risk is likely to be greater in areas closer to Prudhoe Bay (i.e., the Near Zone, Map 4), where exploration and development is likely to be more concentrated because of proximity to the primary support area, than in the more distant portions of the lease sale area. Although most spectacled eiders apparently spend little time in nearshore coastal habitats, at least near Prudhoe Bay, females with broods may occupy them briefly before moving to offshore staging areas (Maps 9a and 9b). While eiders occur inside the barrier islands (approximately 50% of the coastline has adjacent islands), they are protected to some extent from contact by an offshore oil spill. During spring migration, most migrating spectacled eiders arrive at the nesting areas via overland routes; thus, few are likely to occupy leads offshore where they would be vulnerable to oil. In the unlikely event a large oil 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 this occurs. This assumption is supported by results of the spring and fall 2000 North Slope broken-ice exercises during which multiple equipment failures were experienced while attempting to contain and clean up a simulated oil spill in broken-ice conditions and, thus, the simulated oil was not effectively removed from the environment (Robertson and DeCola, 2000). However, the low probability of such an event, the likelihood that a spill will not move into all portions of a given area, and the seasonal nature of the resources inhabiting the Beaufort Sea region, make it unlikely that a large oil spill would occur and contact substantial proportions of the eider populations. Regarding seasonality, although spectacled eiders are present on the North Slope for only 3-5 months of the year, there is a potential for cumulative effects from contact in succeeding years if all oil is not removed from the environment the first year.

Locations of early-season migrant eiders (males, and females that lose clutches) carrying satellite transmitters average 10.1 kilometers offshore, while those migrating later (females and young) average 21.8 kilometers, with some locations beyond 40 kilometers offshore (Map 9a). In the unlikely event a large spill occurs, the Oil-Spill-Risk Analysis model predicts the probability of oil contact in 30 days (from LA2-LA12 and associated pipelines [Maps A-4a and 4b]) to areas where migrants have been located (environmental resource areas from Point Barrow to Endicott Causeway, ERA's 2-7; Sea Segments 1-5, 11, 13, 18b, Harrison Bay, Prudhoe Bay, and nearby ERA's 29-33, 51, 53, 55, 65-73, 80 [Maps A-2c and A-2d]). These range from less than 0.5% to 66% for environmental resource areas and 79% for pipelines, depending on the distance between spill launch areas and resource area (Table A.2-21). These areas are located from about 5-55 kilometers offshore.

Although shoreline and nearshore areas generally are occupied for only a brief period as eiders move offshore from nesting and broodrearing areas, the probability of a spill contacting land segments (Maps A-3a and A-3b) from launch areas and associated pipelines within 30 days ranges up to 21% (Table A.2-27), suggesting that the risk to individuals is not insignificant even in these coastal areas in the unlikely event a spill were to occur. In particular, repeated eider satellite-transmitter locations in Simpson Lagoon west of Prudhoe Bay and outer Harrison Bay suggest that these are important areas for staging and migrating spectacled eiders. Oil-spill-contact probabilities in these areas range up to 23% and 38%, respectively, indicating a substantial risk in these apparently important areas. However, combined probabilities that incorporate the chance of a spill occurring (low) are only 2% or less in these areas.

IV.C.5.b(1)(b)2)d) Mortality from an Oil Spill

Because relatively few spectacled eiders were observed during aerial surveys conducted from Harrison Bay east to Mikkelsen Bay by the Fish and Wildlife Service, modeled estimates of oil-spill mortality for that portion of the coastal plain population occupying this marine area based on these values also were low (Fischer, Tiplady, and Larned, 2002; Stehn and Platte, 2000). The authors state that the predictive value of their model was limited by using some important assumptions such as (1) errors inherent in estimating numbers of birds present in or passing through a prescribed area during aerial surveys performed at one point in time, (2) turnover rates (duration of time a bird spends on the water at a specific site), (3) the possibility that the areas sampled on limited surveys do not accurately represent all areas occupied by eiders, (4) the possibility that a substantial proportion of the unidentified eiders may have been spectacled, and (5) limitations of the bird density/oil-spill-trajectory overlay analysis, that made the final estimates of numbers of birds exposed to oil less certain.

However, even if the model lacks precision, the relative magnitudes and patterns of exposure of birds to oil calculated by the model should have application for the management and protection of birds using this central Beaufort Sea area. If future surveys find similar eider distribution in areas to the west (see Fischer, 2002), the model may have application there as well. Using average estimated bird density and average to maximum severity of spill-trajectory paths, the model estimates that an average of 2 to a maximum of 52 spectacled eiders would be exposed to a large spill in 30 days in July and zero in August. However, if a substantial number of unidentified eiders that were observed in August were spectacled eiders, this latter estimate, in particular, could increase. Also, this range may represent a conservative estimate for potential mortality during periods of active westward migration, because migrants departing each successive area to the west could join those already in migration from the central Beaufort Sea area. Mortality of eiders from an oil spill is expected to be fewer than 100 individuals; however, any substantial losses (25+ individuals) would represent a significant effect. Recovery from substantial mortality would not occur while the population exhibits a declining trend.

IV.C.5.b(1)(b)3) Population Effects

The relatively small loss of spectacled eiders likely to result in the unlikely event of an oil or fuel spill in the Beaufort Sea, where so far there is little indication of large numbers gathering in offshore waters, may be difficult to separate from natural variation in population numbers. This has been found for other waterbird populations under similar circumstances (see USDOI, MMS, Alaska OCS Region, 2002a:Section III.C.2.a(2), which is incorporated by reference, for details). Regardless of the factors involved in causing deaths, which may include effects from lead ingestion and mortality from the subsistence harvest, complete recovery of the Arctic Coastal Plain spectacled eider population from even small losses in the proposed sale area may be slow, because the population apparently has been in a gradual nonsignificant decline from 1992-2001 (Larned et al., 1999, 2001; Larned, Platte, and Stehn, 2001; USDOI, Fish and Wildlife Service, 1999). This probably is due to the species' low reproductive rate and low nesting density in this eastern portion of its range, where eider numbers are relatively low, and the effect of any adverse factors on the population. Recruitment of individuals into the population under such circumstances is likely to be slow; the effect of losses from spill mortality, intensified by low productivity or lowered survival of any age groups, is likely to increase the rate of decline, at least for some interval, and the overall length of time required for recovery to former population levels, which will not occur while the population is decreasing. However, in the absence of specific information bearing on this question for any species occurring in the Beaufort Sea, it is reasonable to assume that any additional mortality occurring as a result of oil and gas development could increase not only the rate of decline for a declining species, at least temporarily, but also would delay the point (i.e., extend the time to status reversal) at which the population could enter a recovery mode (population decline reversed). Also, if additional mortality increases the rate of decline, the population presumably would decrease to a lower level over a given interval; thus, it should take the population longer to recover to a specified former level (i.e., delay recovery) at a given rate of increase.

Because the small amount of information available on factors such as rates of productivity, survival, and recruitment into the population makes it difficult to determine when either the local or entire coastal plain populations would recover from incidents causing mortality, the long-term effect of oil-spill mortality is uncertain. Also, different rates of decline could be ongoing in various parts of the population but undetected between individual survey years by current survey methodology (King and Brackney, 1997). Currently, spectacled eider numbers on the coastal plain generally appear to be stable or declining at a nonsignificant rate (Larned et al., 1999, 2001; Larned, Platte, and Stehn, 2001; USDOI, Fish and Wildlife Service, 1999). While the population is declining, any oil spill or other mortality associated with oil and gas development is likely to extend the period required for recovery, at least until the species recovers from circumstances that resulted in its threatened status. It should be noted, however, that any mortality resulting from a spill is likely to be a one-time occurrence as compared to the relatively unknown but presumably constantly acting factors that are causing this population to decline at a nonsignificant rate. Recovery from losses under these two types of circumstances may be quite different. Recovery from substantial mortality is not likely to occur while the population is declining, but determination of population status may be obscured by natural variation in population numbers.

In addition, recovery from mortality associated with development from the first sale, which is likely to involve the largest losses of the three sales, could be delayed by any mortality resulting from development associated with the following sales. With any substantial mortality, the potential exists for a significant adverse effect on this population.

IV.C.5.b(1)(b)4) Effects of Decreased or Contaminated Prey Populations

Local reduction or contamination of food sources in the unlikely event a large oil spill occurs also could reduce survival or reproductive success of some eiders, which could be a serious effect due to their low reproductive rates and a relatively small regional population. Lowered food intake may slow the completion of growth in young birds, replacement of energy reserves depleted during nesting by females, and energy storage for migration by all individuals. However, the contamination of some local habitats is not likely to affect a large proportion of the regional eider population because (1) they apparently are not abundant in much of the proposed lease area; (2) they do not occur in large feeding flocks; and (3) they would have access to alternative foraging habitat similar in appearance and with similar prey organisms, which is widely distributed in the region (see USDOI, MMS, Alaska OCS Region, 2002a:Section III.C.2a for details). Any eider losses would be recovered slowly while the species is in a declining status.

Conclusions. The effects from normal activities associated with oil and gas exploration and development during three sales in the Beaufort Sea are likely to include the loss of a small number of spectacled eiders. This is most likely to occur as a result of collisions with offshore or onshore structures. Declines in fitness, survival, or production of young may occur where birds frequently are exposed to various disturbance factors, particularly helicopter support traffic. The frequency of such disturbance is likely to be highest in the vicinity of primary support facilities in the Prudhoe Bay area. Although the eider population, which currently is declining at a nonsignificant rate, may be slower to recover from small losses or declines in fitness or productivity, no significant overall population effect is likely. In the unlikely event a large oil spill occurs, spectacled eider mortality is likely to be fewer than 100 individuals; however, any substantial loss (25+ individuals) would represent a significant effect. Recovery from substantial mortality would not occur while the population exhibits a declining trend, but determination of population status may be obscured by natural variation in population numbers.

Effectiveness of Mitigating Measures. Several mitigating measures will be considered for the Beaufort Sea sales that may offer some protection to spectacled eiders. These include ITL clauses on Bird and Marine Mammal Protection and on the Spectacled Eider and the Steller's Eider. Most of the remaining stipulations and ITL clauses are not pertinent to protection of eiders, or would provide minimal benefits to individuals and no measurable benefit to the relatively small and widely dispersed regional spectacled eider population. For example, Stipulations 6a and 6b on the prohibition of permanent facilities within 10 miles of Cross Island would remove some obstructions to eider movement, thereby decreasing the potential for collision. However, few spectacled and no Steller's eiders are likely to occur in this area and, therefore, benefits would be minimal for individual eiders and virtually impossible to measure at the population level.

The ITL clause Information on Bird and Marine Mammal Protection advises lessees that they and their contractors are subject to the requirements of the Endangered Species Act, in particular the incidental take provisions, and applicable International Treaties. Lessees and their contractors should be aware that disturbance of threatened eiders could be determined to constitute a "taking" situation. This section of the ITL does not provide any direct protection for these species, but it does provide information to assure that lessees or their contractors are aware of the Endangered Species Act classification of the species and, thus, indirectly of the special regulatory provisions that govern interactions with them. Lessees also are advised by this ITL that behavioral disturbance of most birds 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. If lessees and their contractors adhered to these recommendations, it is unlikely that either of these species would experience significant disturbance effects, a definite benefit for these threatened populations.

The ITL Information on the Spectacled Eider and Steller's Eider advises lessees that these two species are protected under the Endangered Species Act, and provides information on their seasonal distribution. This

ITL does not provide any direct protection for these species, but it does provide information to assure that lessees and their contractors are aware of the Endangered Species Act classification of the species and, thus, indirectly of the special regulatory provisions that govern interactions with them.

IV.C.5.b(2) Effects of Alternatives and Sales

IV.C.5.b(2)(a) Effects of Alternative I for Sale 186

The effects of normal activities on spectacled eiders under Alternative I for Sale 186 oil and gas exploration and development are likely to be about the same as those described in Section IV.C.5.b(1) - Effects Common to All Alternatives. This is because although eiders staging and migrating in the marine environment are vulnerable to disturbance or oil-spill contact across much of the central and western Beaufort Sea (Fischer, 2002; Fischer, Tiplady, and Larned, 2002; Map 9a), the effects common to all alternatives discussed primarily would occur in the vicinity of central Beaufort primary support facilities where the Near and Midrange zones (Harrison Bay to Mikkelsen Bay) are likely to contain 90% of the Sale 186 leasing activity and three development projects (Table IV.A-4). Fewer eiders are likely to occur in the central offshore portion of the Far Zone, where only 10% of the leasing and exploration activity and no development projects are likely to occur as a result of this sale.

Potential effects include disruption of foraging or other activities, particularly in the vicinity of primary support facilities, where converging support aircraft routes could cause more intensive disturbance than in distant (Far Zone) areas and, thus, displacement of eiders from near helicopter- and vessel-traffic routes during construction and operational activities in the open-water season. Collision with offshore structures is likely to be the greatest source of mortality during normal operations. Brief disturbances (a few minutes to a few days) are not expected to have a significant effect on eider movements and distribution. However, recovery from any collision losses is not likely to occur quickly, while the regional population remains in a declining status (currently nonsignificant).

In the unlikely event a large oil spill occurs under Alternative I for Sale 186, small to substantial numbers of eiders (average of 2 to a maximum of 52; Stehn and Platte, 2000) could be killed. Recovery of losses is not likely to occur while the regional population is in declining status. The probability of spill contact within 30 days in sea segments and other environmental resource areas that are contained within the modeled spill-launch areas that are most likely to contain development under Sale 186 (vicinity of primary support facilities) ranges up to 55% for launch areas and 64% for associated pipelines. These values are lower than those obtained if leasing occurred throughout the planning area with equal intensity, as assumed in Section IV.C.5.b(1) - Effects Common to All Alternatives. This is likely because most leases and developments are likely to occur in the Near Zone (70% of leasing and two developments) or nearby portions of the Midrange Zone (20% and one) close to centrally located primary support facilities in Deadhorse, rather than farther offshore or west where there are some environment resource areas used by eiders that have higher contact probabilities.

Conclusions. The effects from normal activities associated with Alternative I for Sale 186 include nonsignificant disturbance, and the potential loss of small numbers of eiders from collision with structures. In the unlikely event of a large oil spill, the risk of contact is likely to be somewhat lower than if developments were spread throughout the planning area, which could include some areas used by eiders, which have higher contact probabilities indicated by the MMS oil-spill model. Recovery from substantial oil-spill mortality would not occur while the spectacled eider is in a declining status; however, determination of status may be obscured by natural variation in population numbers.

IV.C.5.b(2)(b) Effects of Alternative I for Sale 195

The effects of normal activities on spectacled eiders under Alternative I for Sale 195 oil and gas exploration and development are likely to be less than described in Section IV.C.5.b(1) - Effects Common to All Alternatives, and somewhat less than under Sale 186. The decrease from Sale 186 is because most staging or migrating eiders pass through the Near Zone, where a lower proportion of the leasing and exploration, and just one development under Sale 195 as compared to Sale 186, is expected to occur (50% versus 70%). Also, somewhat less leasing and exploration activity and the same amount of development is likely to occur in the Midrange Zone (Map 4) under Sale 195, but this probably will have little effect. Few eiders are likely to occur in the Far Zone, where 20% of the leasing and exploration activity and no development projects are likely to occur under this sale.

Potential effects include disruption of foraging or other activities, particularly in the vicinity of primary support facilities where converging support-aircraft routes still could cause more intensive disturbance than in distant (Far Zone) areas and, thus, displacement of eiders from near helicopter- and vessel-traffic routes during construction and operational activities in the open-water season. Collision with offshore structures is likely to be the greatest source of mortality during normal operations. Brief disturbances (a few minutes to a few days) are not expected to have a significant effect on eider movements and distribution. However, recovery from any collision losses would not occur quickly while the regional population remains in a declining status (currently nonsignificant).

In the unlikely event of a large oil spill under Alternative I for Sale 195, small to substantial numbers of eiders (average of 2 to a maximum of 52, Stehn and Platte, 2000) could be killed. Recovery of losses is not likely to occur while the regional population is in declining status. The probability of spill contact within 30 days in environmental resource areas that are contained within the modeled spill launch areas most likely to contain development under Sale 195 is the same as for Sale 186. These values are lower than those obtained if leasing and development occurred throughout the planning area with equal intensity, as assumed in Section IV.C.5.b(1) - General Areawide Effects. This result is likely, because most leases and developments are likely to occur in the Near Zone (50% of leasing and 1 development) or nearby portions of the Midrange zone (20% of leasing and 1 development) close to centrally located primary support facilities in Deadhorse, rather than farther offshore or west in the vicinity of some areas with higher contact probabilities.

Conclusions. The effects from normal activities associated with Alternative I for Sale 195 include nonsignificant disturbance, and the potential loss of small numbers of eiders from collision with structures. Disturbance of eiders in the Near Zone is likely to be lower than under Sale 186, because a lower proportion of leasing and exploration is expected to take place there. In the unlikely event of a large oil spill, the risk of contact is likely to be somewhat lower under Sale 195 than under Sale 186, which proposes one more development project than Sale 195, or lower than if developments were spread throughout the planning area, which could include some areas used by eiders that have higher spill-contact probabilities indicated by the MMS oil spill model. Recovery from substantial oil-spill mortality would not occur while the species is in a declining status; however, determination of status may be obscured by natural variation in population numbers. Effects are likely to be somewhat less than those that could occur as a result of Sale 186.

IV.C.5.b(2)(c) Effects of Alternative I for Sale 202

The effects of normal activities on spectacled eiders under Alternative I for Sale 202 oil and gas exploration and development are likely to be considerably less than described for Sales 186 or 195. This is because relatively few eiders are likely to occur in the portion of the Far Zone (Map 4) where 30% of the leasing and exploration activity and the only development project are likely to occur. Any project is likely to be located offshore of centrally located primary support facilities, which are near the eastern limit of common onshore occurrence of this species, suggesting that relatively few spectacled eiders would occur in the adjacent offshore area. The remainder of the Far Zone lies between Harrison Bay and Point Barrow, where eiders may be relatively common but leasing is less likely, because development sites would be far removed from industrial infrastructure.

Potential effects include disruption of foraging or other activities or displacement from within about 1-2 kilometers (0.62-1.2 miles) of helicopter routes to drill sites and vessel traffic during construction and operational activities in the open-water season. Collision with offshore structures is likely to be the greatest source of mortality during normal operations. Brief disturbances (a few minutes to a few days) are not likely to have a significant effect on eider movements and distribution. However, recovery from any collision losses is not likely to occur quickly while the regional population is in declining status (currently nonsignificant).

In the unlikely event a large oil spill occurs under Alternative I for Sale 202, small numbers of eiders may be contacted and die (average of 2 to a maximum of 52, Stehn and Platte, 2000), although the likely area of development (60 % of leasing in the Midrange and Far zones, and just one development in the latter) is beyond the areas where most spectacled eiders frequently would occur. Recovery of losses is not likely to occur while the regional population is in declining status.

Conclusions: The effects from normal activities associated with Alternative I, Sale 202 include a small amount of nonsignificant disturbance and the potential loss of small numbers of eiders from collision with structures. In the unlikely event a large oil spill occurs, the risk of contact is low, because only one development likely would be located where spectacled eiders are relatively scarce. Effects are likely to be considerably less than those that could occur as a result of Sales 186 or 195.

IV.C.5.b(2)(d) Effects of Alternative III, V, and VI for All Sales

Alternative III (Barrow Subsistence-Whaling Deferral) would defer leasing and development in some offshore and western Far Zone areas, where the probability of oil-spill contact within 30 days is relatively high and migrant spectacled eiders are known to occur. However, leasing and development is not likely to occur this far from primary support infrastructure under any of the three sale scenarios and, therefore, effects from normal activities or an oil spill under these alternatives are likely to be the same as under Alternative I for all Sales.

Alternatives V (Kaktovik Subsistence-Whaling Deferral) and VI (Eastern Deferral) would defer leasing and development in areas where few spectacled eiders occur; therefore, effects under these alternatives are to be the same as under Alternative I for Sale 186.

Conclusion: The effects from normal activities, and in the unlikely event a large oil spill occurs, associated with Alternatives III, V, and VI on spectacled eiders are likely to be the same as under Alternative I for Sales 186, 195, and 202.

IV.C.5.b(2)(e) Effects of Alternative IV for All Sales

Alternative IV (Nuiqsut Subsistence-Whaling Deferral) would defer leasing and development in central Beaufort Sea areas where some spectacled eiders are likely to occur. Although these deferrals would lower the probability of eider contact by oil in these areas in the unlikely event a large oil spill occurs, most spectacled eiders occur west of the Sagavanirktok River and their primary distribution is west of the deferred areas. As a result, the decreased risk of oil contacting eiders under these alternatives is likely to be only a small reduction from that expected under Alternative I for Sales 186, 195, and 202.

Conclusion: The effects on spectacled eiders from normal activities, and in the unlikely event a large oil spill occurs associated with Alternative IV, are likely to be somewhat less than under Alternative I for Sales 186, 195, and 202.

IV.C.5.c. Steller's Eider

IV.C.5.c(1) Effects Common to All Alternatives

Observations of this species during aerial surveys on the Arctic Coastal Plain have been extremely sparse and widely dispersed, primarily west of the Colville River and generally within about 60 kilometers of the coast (Map 9b). Most nesting in this region has been observed south and southeast of Barrow; nests have been found there in most years (Quakenbush and Suydam, 1999). Male Steller's eiders stage and migrate as dispersed flocks along the Beaufort or Chukchi coasts soon after the nesting period begins. Females with young may be found farther offshore as a result of migrating later, when the ice usually is farther from the coast (Petersen, 1997, pers. commun.). Substantial numbers of Steller's eiders apparently were taken during subsistence harvests in the 1990's (Georgette, 2000; Paige et al. 1996; Wentworth, 2001). It is not certain what proportion of these individuals were Alaskan or Russian breeders, nor is it certain what role this harvest played in the decline of this species.

IV.C.5.c(1)(a) Effects of Exploration

IV.C.5.c(1)(a)1) Effects from Routine Operations

IV.C.5.c(1)(a)1)a) Effects of Disturbance Factors and Collision

Steller's eiders staging or migrating in coastal Beaufort Sea areas in or adjacent to western blocks of the proposed lease area (western Midrange and Far zones, Map 4) are not likely to experience adverse effects from potentially disturbing routine activities, principally helicopter traffic. This is because of the low probability that the routes traveled and area occupied by scattered coastal flocks of this small Alaskan breeding population would be overflown by support aircraft traveling between onshore facilities in the Deadhorse or Barrow area and the one drill site assumed for the western lease area (Table IV.A-4). It also is unlikely that a primary Alaskan nesting area, located south and southeast of Barrow, would be overflown by helicopters from offshore units; therefore, significant disturbance of nesting or broodrearing eiders is not likely to occur. However, Fischer (2001) observed three Steller's eiders near Cape Simpson in Smith Bay during transects flown in late July 2001. This is an area where a staging facility could be built for barges to offload equipment and, thus, potentially become a source of disturbance if eiders routinely use this nearshore area.

It is likely that any small reduction of available foraging habitat as a result of burial by gravel island or pipeline construction, or disturbance from various activities in the western lease area during the brief time males in late June and females with juveniles in late August occupy coastal waters, primarily in the Barrow area, would have a negligible effect on the small Alaskan breeding population.

It is not likely that significant numbers of Steller's eiders would collide with structures at a single drill site in the western sale area; these eiders are rare in the area east of the Colville River, where most development is likely to occur (see the previous discussion for spectacled eider). Disturbance from coastal cleanup activities in the unlikely event a large oil spill occurs is likely to be minor; offshore cleanup activity within or near the lease area is likely to be quite distant from flocks staging or migrating in coastal areas. Any disturbance of individuals could be considered a "take" under the Endangered Species Act.

IV.C.5.c(1)(b) Effects of Development and Production

IV.C.5.c(1)(b)1) Effects from Routine Operations

Effects from routine operations during development and production are expected to be the same as those under exploration, discussed above.

IV.C.5.c(1)(b)2) Effects of a Large Oil Spill

In the unlikely event a large oil spill occurs, Steller's eiders experiencing moderate to heavy contact oil contact would not survive; most lightly oiled birds also are not likely to survive at arctic water temperatures (see USDOI, MMS, Alaska OCS Region , 2002a:Section III.C.2.a for detailed effects). A minor proportion of the small Alaskan breeding population is likely to be vulnerable to an oil spill, because staging and migrating individuals generally are scattered in relatively few flocks along the coast during the brief summer/fall period of breeding and migration, and the oil would be well weathered and dispersed after moving west from the most likely development areas in the Near Zone (Map 4). Small numbers of spring-migrant Steller's eiders (for example, in 1996, 10 of 182,781 eiders counted = 0.01%; Suydam, et al., 2000) typically are observed during migration counts of eiders past Point Barrow, suggesting that many of the small population nesting in northwestern Alaska may arrive at the nesting areas via overland routes from the Chukchi Sea. If this is the case, relatively few eiders are likely to occupy leads offshore the northern coastline east of Point Barrow where they would be vulnerable to oil entering such habitat (note: 3 eiders were observed near Cape Simpson in Smith Bay during transects flown in late July 2001; Fischer 2001). Given the apparently small population seasonally occupying northwestern Alaska, low Steller's eider mortality is likely from an oil spill; however, recovery of the Alaska population from spill-related losses is not likely to occur, if numbers on the breeding ground continue to decline and the reproductive rate remains relatively low. An onshore spill is not likely to cause significant eider mortality, because the small regional population is widely scattered and pipeline construction in the Barrow area associated with this lease sale, where small numbers of eiders nest, is not certain to occur.

Conclusions. Steller's eiders are not likely to experience adverse effects from potentially disturbing routine activities, collisions with structures, foraging habitat reduction, or oil-spill-cleanup activity. Low Steller's eider mortality is expected in the unlikely event a large oil spill occurs; however, recovery of the Alaska population from spill-related losses would not occur while the regional population is declining.

Effectiveness of Mitigating Measures. Steller's eiders occur mainly onshore and in nearshore waters near the extreme western portion of the proposed lease area. Thus they are not likely to be affected by exploration, development, or production activities, and are not likely to realize any measurable benefits from the proposed mitigating measures. Effects, if any, would be as described above for the spectacled eider.

IV.C.5.c(2) Effects of Alternatives and Sales

IV.C.5.c(2)(a) Effects of Alternative I for Sales 186 and 195

The effects of normal activities on Steller's eiders under Alternative I for Sales 186 and 195 oil and gas exploration and development are likely to be significantly less than those obtained if leasing and development occurred throughout the planning area with equal intensity, as assumed in Section IV.C.5.c(1) - Effects Common to All Alternatives. This is because Steller's eiders using the marine environment rarely occur in the Near or Midrange zones from Harrison Bay east, where 90% of the Sale 186 leasing activity and three development projects and 80% of the Sale 195 leasing activity and two development projects (Table IV.A-4) are expected to occur. In the unlikely event a large oil spill occurs, the probability of contact where Steller's eiders are likely to occur in the Far Zone (ERA 2 from LA9-LA12) is 1% or less and, therefore, substantial mortality is not expected to occur.

Conclusion: The effects of normal activities on Steller's eiders under Alternative I for Sales 186 and 195 are likely to be significantly less than those obtained if leasing and development occurred throughout the planning area with equal intensity. In the unlikely event a large oil spill occurs, substantial mortality is unlikely to occur.

IV.C.5.c(2)(b) Effects of Alternative I for Sale 202

The effects of normal activities on Steller's eiders under Alternative I for Sale 202 oil and gas exploration and development potentially could be higher than those resulting from leasing and development occurring throughout the planning area with equal intensity, as assumed in Section IV.C.5.c(1) - Effects Common to All Alternatives. This is because up to 30% of the leasing activity and one development may occur in the Far zone and, thus, potentially could take place in the western Far Zone where Steller's eiders may be present. Under this relatively unlikely scenario (because this area is far from oil industry infrastructure in the central Beaufort), an oil spill originating at the one development site potentially could contact eiders in this area. However, even if development in the western area occurred, in the unlikely event of a large oil spill it is unlikely that substantial numbers of eiders would be affected because of their low numbers and scattered distribution; thus, it is unlikely that significant effects would occur. It is more likely that effects would be lower than described for effects common to all alternatives for leasing and development, and about the same as under Alternative I for Sales 186 and 195.

Conclusion: The effects of normal activities on Steller's eiders under Alternative I for Sale 202 are likely to be significantly less than those obtained if leasing occurred throughout the planning area with equal intensity, and about the same as indicated for Sales 186 and 195. In the unlikely event of a large oil spill, substantial mortality is unlikely to occur.

IV.C.5.c(2)(c) Effects of Alternative III for All Sales

Alternative III (Barrow Subsistence-Whaling Deferral) would defer leasing and development in some offshore and western Far Zone areas where, in the unlikely event a large oil spill occurs, the probability of oil contact within 30 days is relatively high and migrant Steller's eiders may occur. However, the likelihood that leasing and development would occur this far from primary support infrastructure in the central Beaufort is low and, therefore, effects from normal activities or an oil spill under these alternatives are expected to be the same as under Alternative I for Sales 186, 195, and 202.

Conclusion: The effects from activities and any oil spill associated with Alternative III on Steller's eiders are likely to be the same as under Alternative I for Sales 186, 195, and 202.

IV.C.5.c(2)(d) Effects of Alternatives IV, V, and VI for All Sales

Because Alternatives IV (Nuiqsut Subsistence-Whaling Deferral) and V (Kaktovik Subsistence-Whaling Deferral) would defer leasing and development in areas where Steller's eiders rarely, if ever, are sighted, effects under these alternatives are likely to be the same as under Alternative I for Sales 186, 195, and 202.

Conclusion: The effects from activities and any oil spill associated with Alternatives IV, V, and VI on Steller's eiders are likely to be the same as under Alternative I for Sales 186, 195, and 202.

IV.C.6. Marine and Coastal Birds

IV.C.6.a. Effects Common to All Alternatives

Several million migratory birds of about 70 species occur in the Beaufort Sea region, occupying offshore and coastal marine, freshwater, and tundra habitats during the summer breeding and summer/fall migration seasons. Seasonal distribution of birds in the region determines their vulnerability to potentially adverse factors associated to a large extent with oil and gas exploration and development to a large extent. Loons, waterfowl, shorebirds, and the few seabird species are among the most vulnerable to exploration and development activities. Aerial surveys in the central Beaufort Sea have documented that birds are widespread in substantial numbers in both nearshore and offshore waters of this area (Fischer, 2002; Fischer, Tiplady, and Larned, 2002; Larned, Platte, and Stehn, 2001; Stehn and Platte, 2000), and it is likely that approximately this distribution and abundance prevails along the entire Beaufort coastline and into the northern Chukchi Sea, although some surveys in the eastern Beaufort suggest there are lower numbers in that area. Birds occur out to at least 70 kilometers offshore where open water is available. Of the more common species in marine waters, Pacific loons, king eiders, glaucous gulls, and jaegers are dispersed at all distances offshore; the common eider, scoters, and a majority of long-tailed ducks mainly occupy nearshore waters (Maps 10a, 10b and 11a). Onshore, nesting waterfowl, shorebirds, gulls, and terns are widespread in most coastal habitats.

IV.C.6.a(1) Effects of Exploration

IV.C.6.a(1)(a) Effects of Routine Operations

IV.C.6.a(1)(a)1) Effects of Aircraft/Vessel Disturbance

The response of birds to disturbance varies according to the species, the physiological and reproductive status of individuals, distance from the disturbance, and type/intensity/duration of the disturbance. Local populations of species nesting on barrier islands, river deltas, or coastal wetlands, or molting/staging/migrating in coastal or offshore areas, are likely to experience brief but not significant disruption of these activities, primarily from helicopter flights (10-20 flights/day during construction; 0.5-1/day during production [Table IV.A-4]) during the open-water season. This is because over most of the lease area, routine flights following relatively direct flight paths between a few offshore drill sites (for example, a maximum of three sites for Sale 186) and primary support facilities at Deadhorse and vicinity are not likely to frequently overfly flocks that typically are rather widely scattered; thus, they are likely to cause only intermittent displacement of birds from within 1-2 kilometers (0.62-1.2 miles) of flight paths.

However, molting, staging, or migrating loons and waterfowl occurring in lagoons and other nearshore waters in the Near Zone, or waters just offshore of this area in the Midrange zone (Maps 4, 10a, 10b, and 11a), relatively close to primary support facilities at Deadhorse and vicinity, are much more likely to be overflown than those in the more distant portions of the lease area (eastern and western Midrange and Far zones). This could occur when helicopter flight paths from a few scattered offshore drill sites to the central support area converge in the airspace over waters of the Near Zone and nearest portions of the Midrange

Zone such that a greater proportion of this area is overflown. The convergence effect will be more intense for Sale 186, with two development sites in the Near Zone and one in the Midrange Zone (Appendix B, Table B-1) than for Sale 195 (1, 1, 0) or Sale 202 (0, 0, 1). As a result, it is likely that birds nesting in coastal areas, on barrier islands, or routinely foraging along support helicopter routes will be disturbed and potentially displaced more frequently than those farther offshore or east or west. Relatively intense disturbance could result in seasonal abandonment of some local areas.

Aerial surveys in the central Beaufort Sea conducted by the Fish and Wildlife Service several times during the open water season in 1999 and 2000 found 73.8 long-tailed ducks, 56.4 common eiders, 10.4 king eiders, and 0.3 Pacific loons per square kilometer, suggesting that substantial numbers could be overflown in the Near and Midrange zones (Maps 10a, 10b, and 11a) where most development is likely to take place (Fischer, Tiplady, and Larned, 2002; Stehn and Platte, 2000). Surveys in 2001 covering the area from Point Barrow to Demarcation Point (Fischer, 2002) found substantial numbers of king eiders from Harrison Bay westward (western Midrange and Far zones). Common eider nesting colonies on barrier islands and large numbers of long-tailed ducks molting in lagoons are particularly susceptible (potentially thousands of molting long-tailed ducks; Maps 10a and 10b) (Johnson, 1984; Johnson, Herter, and Bradstreet, 1987). However, studies by Gollup, Goldsberry, and Davis (1974) suggest that if aircraft-disturbance events are relatively infrequent and of short duration, long-term displacement or abandonment of molting and foraging areas by long-tailed ducks, for example, is unlikely. Likewise, brant colonies and broodrearing areas and snow goose colonies, particularly in coastal locations from Harrison Bay west to Dease Inlet, species that are highly sensitive to aircraft disturbance (Derksen et al., 1992), could experience adverse effects during nesting, broodrearing, and molting as a result of aircraft overflights. However, because this area primarily is adjacent to the Far Zone, development is likely to be deferred for an indeterminate period, depending on oil prices and indications of the presence of oil resources.

The occurrence of occasional larger flocks and a disturbance corridor up to about 2 kilometers (1.2 miles) in width along flight paths suggests a disturbance event occasionally could involve substantial numbers of waterfowl and other birds. This is not likely to increase mortality significantly; however, a small portion of the population may experience increased stress and somewhat lowered fitness if they are routinely displaced from favored foraging sites. This could be a problem especially soon after arrival in late spring when there is limited access to ice-free foraging areas, or during the fall staging period, which could cause depletion of stored energy and/or adversely affect the ability of birds to acquire the critical energy reserves necessary for successful migration when energy requirements are high. However, in the case of sea ducks and other bottom feeders, bottom-survey-video records indicate that alternative foraging habitat, similar in appearance and with similar prey organisms present, is widely distributed in the region (LGL Ecological Research Assocs., Inc. 1998). Disruption of postbreeding and juvenile shorebird foraging activity may hamper their ability to acquire critical fat reserves needed to complete migration (Connors, 1976). The net result of decreased energy availability may be somewhat lower survival and/or productivity, from which the regional population would not recover if it is in a declining status. Because of the time lapse between sales, no significant overall effect is likely to result from these minor adverse effects associated with each individual sale, or all three collectively.

In addition, productivity of most species may be affected adversely if displaced adults are no longer able to protect eggs or young from predator populations (for example, foxes, gulls), which have increased as a result of decreased trapping pressure (foxes, as noted by Barrow elders in USDOI, Fish and Wildlife Service, 1996) or increased availability of human-generated food. Relatively few mainland coastal nest sites of individual species are likely to be overflown by helicopters from offshore units, because most are scattered at low density on tundra areas and, thus, substantial disturbance of nesting or broodrearing birds is not likely to occur.

Frequent boat-traffic disturbance of nesting ducks has resulted in a 200-300% increase in the gull-predation rate on duck eggs and young ducklings in nesting areas that occur within 200 meters of gull colonies, when compared to predation rates at undisturbed duck-nesting areas (Ahlund and Gotmark, 1989). Birds nesting on barrier islands and river deltas are particularly susceptible to such predation.

The net result of these various scenarios is likely to be somewhat lower survival and/or productivity; however, losses are not likely to be significant because of the relatively low probability that areas occupied by scattered flocks during the relatively brief staging and migration periods, or nest sites during the brief nesting season, would be overflown frequently by support aircraft flying between drill sites and shore bases. Because of the time lapse between sales, no significant overall effect is likely to result from these minor adverse effects associated with each individual sale, or all three collectively.

IV.C.6.a(1)(a)2) Effects of Other Disturbance Factors and Habitat Alteration

Any construction activities that take place in summer, associated with drill-rig placement during exploration and facilities for development, could temporarily (i.e., one season or less) displace birds using areas near such sites. This local disturbance of birds within about 1 kilometer of construction activities would be short term, and is not likely to cause significant population effects. Few birds would be expected to occur in these relatively small areas (represents less than 1% of potential comparable foraging habitat available in the proposed lease sale area). Likewise, localized burial of potential prey and destruction of a few square kilometers of foraging habitat as a result of pipeline trenching or island construction is not likely to cause a significant decline in prey availability. Disturbance of maximum numbers of birds is likely to occur in the general vicinity of Prudhoe Bay, because most development probably will focus on this area. However, it is likely that much construction, particularly of pipelines and gravel islands, would take place during winter when most birds are absent.

Onshore, because nest sites are scattered at low density on the Arctic Coastal Plain, relatively few are likely to become unavailable through burial or location in areas of gravel extraction, and only small numbers of nesting birds are likely to be displaced away from the vicinity of onshore pipeline corridors (few hundred meters) by construction activity (lasting about 2 years), vehicle-traffic disturbance, or helicopter traffic for pipeline inspections. Although burial would result in permanent removal of habitat, routine disturbance effects would persist only over the life of the field (potentially up to 28 years), and they would be localized primarily within about a kilometer of the pipeline. Positive effects may be realized from water impoundments and early-season food-plant growth in dust shadows along any new roads, which would benefit waterfowl; however, the availability of shorebird insect prey is likely to be adversely affected near roads, and some shorebird-nesting attempts would be displaced. Net habitat loss and disturbance effects on most species' productivity are not expected to be substantial but would persist over the life of the field in the local areas affected. Because of the time lapse between sales, no significant overall effect is likely to result from these minor adverse effects associated with each individual sale, or all three collectively.

IV.C.6.a(1)(a)3) Effects of Collisions with Structures

Because sea ducks typically fly at a relatively low altitude over water (Johnson and Richardson, 1982), the potential exists for these birds to collide with offshore structures that protrude above the surface. This would be true especially under conditions of poor visibility (for example, fog or darkness), and may be compounded by the potentially attracting or disorienting effect of lights on the structures at night. The lack of information on routes followed by most species during migration and other activities in the Beaufort Sea, and specific behavior near and vulnerability to obstructions during migration, makes it difficult to estimate potential mortality. With regard to the potential problems caused by structure lighting, under terms of the Beaufort Sea Planning Area lease sale EIS Biological Opinion prepared by the Fish and Wildlife Service (USDOI, Fish and Wildife Service, 2002), the MMS and the Fish and Wildlife Service will jointly develop a protocol for lighting systems for offshore structures that may reduce the likelihood of bird collisions with such structures.

Although the collision of a flock of waterfowl or shorebirds, or small numbers of loons, with artificial islands or drill structures could result in substantial mortality, such structures actually will be relatively small obstructions in the Beaufort Sea, very likely few in number (three or fewer; Appendix F, Table F-3), and most ducks are likely to see and avoid them when visibility is good. However, recent (late September/October 2001) bird fatalities at the currently operational Northstar island apparently occurred equally on days with good visibility conditions (although some of these may have occurred at night) and foggy conditions (Taylor, 2001, pers. commun.). In 2001, 20 birds were retrieved at Northstar island, all sea ducks, including 4 king eiders, 8 common eiders, and 8 long-tailed ducks. Because the typical density of most species in the Beaufort area during most of the period they are present is relatively low, mortality from collisions with islands or drilling structures also is likely to be low. However, during periods of migration there is a potential for substantial numbers of flocks containing large numbers of individuals to pass near such structures, with the possibility of collision by some birds. The risk is expected to be greater in areas closer to Prudhoe Bay (i.e., the Near Zone, Map 4), where exploration and development structures are most likely to be located because of proximity to primary support facilities rather than in the more distant portions of the lease area, where development is less likely to occur.

Collision of nesting waterfowl with the elevated onshore portion of pipelines is considered unlikely, because they are likely to be at a very low density near a pipeline, and most of their activities would involve walking or swimming rather than flying. Departing males and unsuccessful females flying to the marine environment could strike onshore pipelines. Overall, mortality from pipeline collisions is likely to be negligible.

IV.C.6.a(1)(a)4) Effects of Discharges

Discharges from drilling operations during exploration and development/production typically disperse rapidly in the surrounding water, although some may be deposited on the bottom near drill sites. Because bottom-feeding sea ducks and guillemots occur in dispersed flocks, relatively few are expected to occur in or rely specifically on prey potentially affected or buried at six project drill sites during the 28-year development period. Thus, discharges are not likely to cause significant effects either through direct contact with birds or by affecting prey availability as a result of the three sales individually, or all three collectively, due to the insignificance of any additive effects. Drilling structures, the source of most discharges, are likely to be quite dispersed, with just two in the Near Zone, one in the Midrange Zone, and none in the Far Zone (Map 4) for Sale 186 (Sale 195-1, 1, and 0; Sale 202-0, 0, and 1). In addition, there likely is sufficient time between sales for regional bird populations to recover from the minor effects that may result from each sale. For similar reasons, new pipeline construction (estimated to be 0 miles for Sale 186, 40 miles for Sale 195, and 35 miles for Sale 202) is not likely to cause significant effects.

IV.C.6.a(2) Effects of Development and Production

IV.C.6.a(2)(a) Effects from Routine Operations

Effects from routine operations during development and production are likely to be the same as those previously discussed under exploration.

IV.C.6.a(2)(b) Effects of an Oil Spill

IV.C.6.a(2)(b)1) Effects of Disturbance from Oil-Spill Cleanup

In the unlikely event of a large oil spill, the presence of large numbers of cleanup workers, boats, and additional aircraft is likely to displace waterfowl, loons, and shorebirds foraging in affected offshore, nearshore, and/or coastal habitats during open-water periods for one to several seasons. Disturbance during the initial season, possible lasting 6 months, is expected to be frequent. Cleanup in coastal areas late in the breeding season may disturb broodrearing, juvenile, or staging birds. Staging or migrating flocks of some species generally are dispersed and, thus, would not necessarily occur in the vicinity of the cleanup activity. As a result, relatively few flocks are likely to be displaced from favored habitats and expend energy stores accumulated for migration. However, numerous large flocks of molting long-tailed ducks in lagoons, in addition to common eiders occupying barrier islands or lagoons, are particularly susceptible if they are nesting, broodrearing, or flightless. 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. Survival and fitness of individuals may be affected to some extent, but this infrequent disturbance is not likely to result in significant population losses.

IV.C.6.a(2)(b)2) Effects of a Large Oil Spill

Exposure of loons, waterfowl, seabirds, and shorebirds to oil is expected to result in the general effects reviewed in USDOI, MMS, 1996a; USDOI, MMS, Alaska OCS Region, 2002a:Section III.C.2). Individuals would not survive moderate to heavy oil contact; most lightly oiled birds also are not likely to survive at arctic water temperatures. Swallowed oil may cause impaired physiological function and production of fewer young.

IV.C.6.a(2)(b)2)a) Vulnerability of Birds to Oil Spills

In the unlikely event a large oil spill occurs during summer or fall periods when molting, staging, or migrating waterfowl, seabirds, and shorebirds occupy open-water marine habitats, a highly variable proportion of their Arctic Coastal Plain populations could be vulnerable to oil in the Beaufort Sea (Maps 10a, 10b, and 11a). The probability 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:Table 10; Maps 10a, 10b, 11a, and 11b). However, some flocks may be relatively large (mean sea duck flock size in nearshore areas = 11-34 individuals; in offshore areas, 6-22 individuals; Fischer, Tiplady, and Larned, 2002), and any contact could result in substantial losses. The risk is likely to be greater in areas closer to Prudhoe Bay (i.e., the Near Zone, Map 4) where exploration and development is likely to be more concentrated because of proximity to the primary support area than in the more distant portions of the lease area. Flocks foraging inside the barrier islands (approximately 50% of the coastline has adjacent islands) are protected to some extent from oil-spill contact. During spring migration, many migrant waterfowl arrive at the nesting areas via overland routes; thus, few of these are likely to occupy leads offshore where they would be vulnerable to oil; king eiders, however, do occupy offshore spring leads in substantial numbers, and loons and several duck species are common in nearshore leads and open water off river deltas. Waterfowl, shorebirds, and most seabirds are absent from the area essentially from late October to May. However, in the unlikely event 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. This assumption is supported by results of the spring and fall 2000 North Slope broken-ice exercises during which it was evident that further equipment design changes will be required to enhance oil recovery in broken-ice conditions (Robertson and DeCola, 2000).

In the unlikely event a large spill occurs, the vulnerability of bird populations to oil contact is highly variable as a result of their irregular distribution during the open-water season and the relatively small period (3-5 months) during which molting, staging, and migrating individuals or flocks could be exposed to a spill. The low probability of such an event, the likelihood that a spill will not move into all portions of a given area, and the seasonal nature of the resources inhabiting the area, make it unlikely that a large oil spill would occur and contact substantial proportions of these resources. However, although long-tailed ducks, and king and common eiders, for example, are present in the Beaufort Sea region only seasonally, there is a potential for cumulative effects from contact in succeeding years when vulnerable birds are present, if all oil is not removed from the environment the first year.

The MMS Oil-Spill-Risk Analysis model predicts that the probability of oil contacting any coastal or offshore environmental resource areas out to about 55 kilometers/35 miles offshore within 30 days (see the discussion of spill-launch areas, pipelines, and environmental resource areas and identification numbers in Appendix A-1-C.1.a to C.1.h. ranges from less than 0.5-66% from spill-launch areas and 79% (Table A.2-21) from pipelines, depending on the distance between launch points and environmental resource areas (Maps A-4a and 4b). If groups of land segments are considered, contact probability from a summer spill in the easternmost launch area within 30 days in several areas of concern ranges from 0.5% at Kendall Island Bird Sanctuary in the Mackenzie River Delta to 2% at Herschel Island Territorial Park (Table A.2-87). Thus, the risk to large numbers of postbroodrearing snow geese that nest there is not substantial. However, the risk to coastal resources of the Arctic National Wildlife Refuge is substantial. The probability of summer contact in 30 days ranges from 15-49% at the Refuge's coastline from launch areas adjacent to the Refuge. This suggests potentially substantial losses of migrating long-tailed ducks (common during molt), common eiders (common migrant) and king eiders uncommon migrant) in addition to numerous individuals of several shorebird species.

If only lagoons and other coastal areas and nearshore waters are considered, the maximum probability of spill occurrence and contact drops to 21% (Table A.2-27). This suggests a lower risk of contact and assumed mortality for long-tailed ducks, the most abundant species that gather in aggregations of several thousands to molt in central Beaufort lagoons, in addition to common eiders that nest on barrier islands (Map 11b). However, contact probabilities in Simpson Lagoon and outer Harrison Bay areas, for example, where large numbers of long-tailed ducks in addition to king eiders and other species occur (Maps 10b, 11a, and 11b), range up to 23% and 38%, respectively. As noted, for purposes of modeling and determining which areas are at highest risk, the foregoing contact probabilities assume that a spill occurs; if the probability of spill occurrence is incorporated, the probability of oil contacting any environmental resource area or land segment is 2% or less (Table A.2-55).

The risk of contact is expected to be greater in the vicinity of Prudhoe Bay (i.e., Near Zone, Map 4), where more development is expected because of its proximity to the primary support facilities, than in the more distant portions of the proposed lease area. For example, two development projects are proposed for Sale 186 in the Near Zone, one in the Midrange Zone, and none in the Far Zone, while Sale 202 proposes one development only in the Far Zone.

IV.C.6.a(2)(b)2)b) Mortality from an Oil Spill

Aerial surveys conducted in the Harrison Bay to Mikkelsen Bay area by the Fish and Wildlife Service in 1999 and 2000 recorded substantial numbers of about 20 bird species distributed along the shoreline and seaward to about 60 kilometers (Fischer, Tiplady, and Larned, 2002; Stehn and Platte, 2000; Maps 10a,b and 11a). Estimates of oil-spill mortality for that portion of the coastal plain population occupying this marine area after nesting were calculated using a model that simulated oil-spill movement over time. In addition to the necessity of assuming large oil-spill occurrence, an unlikely event, the authors state that the predictive value of their model was constrained by the incorporation of a number of important assumptions that contribute to the uncertainty of final model estimates of numbers of birds exposed to oil. These assumptions include (1) errors inherent in estimating numbers of birds present in or passing through a prescribed area during aerial surveys performed at one point in time, (2) no consideration of turnover rates or duration of time a bird spends on the water at a specific site or movements during the period a spill was present, (3) the possibility that the areas sampled on limited surveys do not accurately represent all areas occupied by each bird species, (4) assumption of uniform rather than clumped bird distributions, and (5) limitations of the bird density/oil-spill-trajectory overlay analysis that made the final estimates of numbers of birds exposed to oil less certain. Together, these have considerable potential to influence the number of deaths predicted to result from the oil-spill scenarios analyzed, and indicate the difficulty of determining the actual levels of mortality. However, even if the model lacks precision, the relative magnitudes and patterns of exposure of birds to oil calculated by the model should have application for the management and protection of birds using the Beaufort Sea area.

Long-tailed ducks were the most abundant species found in the nearshore or offshore Beaufort Sea area during these surveys (i.e., up to 37,792 estimated to be present during one survey period), followed by king eiders (19,842), scoters (4,814), common eiders (3,300), glaucous gulls (2,478), and Pacific loons (764). Using average estimated bird-density calculated from these values, and average severity of spill-trajectory paths (i.e., numbers of birds exposed to oil averaged across all possible spill paths and bird densities) and, thus, exposure of birds to oil, the Fish and Wildlife Service model estimates, for example, that at average bird densities and severity of oil-spill movement an average of 1,443 long-tailed ducks, 232 king eiders, 147 scoters, 159 common eiders, 217 glaucous gulls, and 23 Pacific loons could be exposed to a large spill (5,912 barrels) within 30 days in July (Stehn and Platte, 2000). In August, comparable exposure values were 2,062 long-tailed ducks; 8 king eiders; 22 scoters; 125 common eiders; 72 glaucous gulls; and 9 Pacific loons.

These values may represent conservative estimates for potential mortality during the molting period of long-tailed ducks and common eiders, because some proportion would be unable to avoid a spill by flying away. Also, substantial numbers of birds migrating westward from eastern localities could temporarily stop and join those molting or staging in a given area thereby increasing the numbers that could be exposed to a spill there; in each successive area to the west, this effect could be multiplied as more birds join the westward migration stream. Estimates of maximum mortality, calculated from the interaction of higher bird densities and spill movements that expose larger numbers of birds to oil, are 4-19 times as large as the mean values. Also, many individuals of several species remain in the Beaufort beyond the date of the last surveys made during the Fish and Wildlife Service study. In fact, only data that allow determination of waterbird densities are useful for making such mortality estimates, using the MMS oil-spill-model estimates of area covered by a spill. Prior to the migration period, it is reasonable to assume that offshore densities would dictate the number of individuals exposed to a spill and not the larger number passing during the migration period. During migration periods, potentially much greater mortality could occur, as new migrants enter the spill area. However, unless migrant sea ducks alight on the water during migration, they are not particularly susceptible to oiling. In addition, a spill in a particular area during summer would not necessarily move far enough to substantially affect those birds moving offshore from nesting areas much farther to the west, but it could oil migrants from the east. For example, a spill in the Prudhoe Bay area probably would not affect a substantial proportion of birds that nest on the western coastal plain, but it would be expected to potentially affect those flying across the Beaufort from Canada and eastern Alaska.

The MMS oil-spill model predicts that a 4,600-barrel oil spill, an unlikely event, would occupy a discontinuous area (i.e., oil assumed to sweep over the entire spill area, but at any given moment appears as a series of separate patches of oil) of about 320 square kilometers after 30 days (Table IV.A-6b). This suggests that, for example, using the bird densities in Stehn and Platte (2000) for the central Beaufort area, along some nearshore lagoon areas it would not be unusual for about 773-5,372 long-tailed ducks to be oiled and, in areas east of Mikkelsen Bay, a spill could contact up to 23,600 molting individuals. Other species with smaller numbers dispersed in this area are likely to experience lower mortality from a spill, for example: 176 king eiders, 91 scoters, 568 common eiders, 487 glaucous gulls, and 17 Pacific loons. The model also predicts about 49 kilometers of coastline would be oiled as a result of a spill of this size, suggesting that hundreds to low thousands of shorebirds (Larned et al., 2001) that pause along the coast during migration potentially could be exposed to beached oil.

Survey data obtained in late July 2001 (Fischer, 2002) spanning the Beaufort from Point Barrow to Demarcation Point suggest that offshore bird distributions across this area generally were similar to those found within the more extensively surveyed central area in 1999 and 2000 (Maps 10a and 10b; note that apparently higher offshore bird densities in the central Beaufort Sea region, as compared to areas farther east or west, may be partly an artifact of sampling intensity. This is because aerial survey flight lines along which birds were counted during 1999 and 2000 were separated by only 5.4 kilometers and confined to the area between Harrison Bay/Cape Halkett to Mikkelsen Bay/Brownlow Point in the central area, as compared to 10 kilometers in the 2001 survey, which covered the entire Alaskan Beaufort coast from Point Barrow to Demarcation Point. Thus, lines along which birds are plotted are closer together and almost twice as numerous in the central area as to the east and west. A notable exception was observed for the king eider, which was distributed farther offshore than in July 1999 or 2000 and almost exclusively west of Harrison Bay (Map 11a). This suggests that in some years, substantial numbers of king eiders could be vulnerable in this area; a 4,600-barrel spill could contact an area containing 544 of these eiders in 30 days. However, in this portion of the Far Zone, little development is expected because of its distance from primary support facilities at Deadhorse.

Of the three proposed sales, Sale 186 with two development projects in the Near Zone and one in the Midrange Zone would present the greatest potential for exposing birds to an oil spill, because these two zones are where most molting, staging, and migrating birds are found.

IV.C.6.a(2)(b)2)c) Population Effects

The effect of the death of several thousand long-tailed ducks on the regional population may be substantial, regardless of whether the current population is 67,010 and undergoing a significant recent decline, as estimated by the Fish and Wildlife Service Aerial Breeding Pair Survey (Mallek, 2001), or 35,609 and either stable or slightly increasing, as estimated by the Fish and Wildlife Service Eider Breeding Population Survey, which is conducted annually about 2 weeks earlier (Larned et al., 2001). However, mortality at the higher levels predicted by the Fish and Wildlife Service oil-spill model is expected to result in a significant long-term adverse effect on the regional population. If the results of the eider survey accurately reflect the current population situation, recruitment could replace a portion of the loss within several generations; if the breeding pair survey results are more accurate and the population is in fact declining significantly, we would not expect recovery until the population stabilizes or is increasing.

The recovery period required for a loss from the suite of species typically occupying the nearshore and offshore Beaufort Sea of up to about 10,000 individuals is difficult to estimate, because species will recover at different rates. Most species with low reproductive rates or population levels (for example, loons, common eider, black guillemot) are not likely to suffer high mortality as a result of an oil spill, because they are not abundant in most of the proposed the sale areas and do not occur in large feeding flocks, although any losses would be recovered slowly due to relatively low reproductive rates. In the case of king and common eiders, because they have experienced substantial losses over the past several decades, mortality at the higher levels estimated by Fish and Wildlife Service data are expected to represent a significant effect.

The relatively small losses of most species, other than the long-tailed duck, likely to result from an oil or fuel spill in the Beaufort Sea 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)). Regardless of the factors involved in causing mortality, complete recovery of the Arctic Coastal Plain populations of some species (such as eiders) from even small losses in the proposed lease area would not occur until their populations, which apparently have been declining since 1992, stabilize or are increasing (Larned et al., 1999; Larned, Platte, and Stehn, 2001; USDOI, Fish and Wildlife Service, 1999). This probably is due to these species' low reproductive rate. Recruitment of individuals into the population under such circumstances is likely to be low and losses from spill mortality, intensified by low productivity or lowered survival of any age groups, is likely to increase the length of time required for recovery to former population levels, once the population status becomes favorable to this occurrence. In the absence of specific information bearing on this question for any species occurring in the Beaufort Sea, it is reasonable to assume that any additional mortality occurring as a result of oil and gas development could increase not only the rate of decline for a declining species, at least temporarily, but also would delay the point (i.e., extend the time to status reversal) at which the population could enter a recovery mode (population decline reversed). Also, if additional mortality increases the rate of decline, the population presumably would decrease to a lower level over a given interval and, thus, it should take the population longer to recover to a specified former level (i.e., delay recovery) at a given rate of increase.

Because the small amount of information on factors such as rates of productivity, survival, and recruitment into the population currently available makes it difficult to determine the recovery rate of either local or entire coastal plain populations from incidents causing mortality, the long-term effect of oil-spill mortality is uncertain. Also, different rates of decline could be ongoing in various parts of the population but undetected between individual survey years by current survey methodology (King and Brackney, 1995; Mallek and King, 2000). Currently, numbers of most species on the coastal plain generally appear to be stable, or increasing or declining at nonsignificant rates (Larned et al., 2001; Larned, Platte, and Stehn, 2001; USDOI, Fish and Wildlife Service, 1999).

Of major species surveyed, only the red-throated loon population appears to be declining at a significant rate (Larned, et al., 2001; Gotthardt, 2001). Arctic tern and brant populations are increasing significantly. Those populations declining at nonsignificant rates include the yellow-billed loon, Sabine's gull, Canada goose, and snowy owl. Nonsignificant upward trends are displayed by the Pacific loon, jaegers, glaucous gull, northern pintail, greater scaup, long-tailed duck, king eider, snow goose, white-fronted goose, tundra swan, small shorebirds, and short-eared owl. When a population is declining, the point at which recovery from any oil spill or other mortality associated with oil and gas development begins will be delayed until the species recovers from its decline. In addition, recovery from mortality associated with the first sale, which is likely to involve the largest losses of the three sales due to the presence of two drill sites in the relatively small Near Zone where bird activity is concentrated, could be delayed by any mortality resulting from development associated with the following two sales. With any substantial mortality, which could occur if substantial proportions of migrants from nesting areas outside a contacted spill area were to be affected, the potential exists for a significant adverse effect on Beaufort Sea populations of eiders and long-tailed ducks.

IV.C.6.a(2)(b)2)d) Effects of Decreased or Contaminated Prey Populations

Local reduction or contamination of food sources in the unlikely event a large oil spill occurs also 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 any species' regional population, because most exhibit a dispersed breeding distribution. However, it could be a serious effect for species with low reproductive rates, with a relatively small regional population, and/or that is experiencing periods of regional population decline in the past decade, such as the northern pintail, long-tailed duck (some surveys), and red-throated loon. Effects during seasonal migration, when birds are more likely to occur in flocks and require high levels of energy intake, could have a more severe population effect. 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 regional bird populations, 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).

Conclusions. The adverse effects on marine and coastal birds from normal exploration and development/production activities during three sales in the Beaufort Sea are likely to include the loss of small numbers of marine and coastal birds. This is most likely to occur as a result of collisions with offshore or onshore structures. Declines in fitness or survival of individuals or production of young may occur where birds frequently are exposed to various disturbance factors, particularly helicopter traffic, causing displacement from preferred use areas, and increased levels of energy use and predation. The frequency of such disturbance is likely to be highest in the vicinity of primary support facilities in the Prudhoe Bay area. Disturbance of local nesting birds probably would have little effect on Arctic Coastal Plain bird populations as a whole. However, recovery from small losses or declines in fitness or productivity of populations currently declining at a nonsignificant rate, in addition to those declining at a significant rate, would be delayed until the population stabilizes or increases. No significant overall population effect is likely to result from small losses for most species.

In the unlikely event a large oil spill occurs, mortality 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). As the most abundant species, long-tailed duck mortality is likely to exceed 1,000 individuals, while that of other common species such as king eider, common eider, and scoters likely would be in the low hundreds, and loon species fewer than 25 individuals each. Mortality at the higher levels predicted by Fish and Wildlife Service data could result in significant effects for long-tailed duck, king eider, and common eider. The probability of a large oil spill occurring, low throughout the planning area, is likely to decrease from the Near Zone to the Far zone due to the greater likelihood of oil development in the former area.

Effectiveness of Mitigating Measures. Several mitigating measures will be considered for the Beaufort Sea sales that may offer some protection to spectacled eiders. This includes the ITL clause on Bird and Marine Mammal Protection. Most of the remaining stipulations and ITL clauses are not pertinent to protection of birds, or would provide minimal benefits to individuals and no measurable benefit to the regional populations of the various species, many of which are relatively small and/or widely dispersed. For example, Stipulations 6a and 6b, prohibition of permanent facilities within 10 miles of Cross Island, would remove some obstructions to movements of species such as loons, the long-tailed duck, king eider, and common eider, thereby decreasing the potential for collision. However, although individuals of these species might benefit minimally, it appears that it would be virtually impossible to measure benefit at the population level.

The ITL on Information on Bird and Marine Mammal Protection advises lessees that they and their contractors are subject to the requirements of the Endangered Species Act, in particular the incidental take provisions, and applicable International Treaties. This section of the ITL does not provide any direct protection for bird species, but it does provide information to lessees and their contractors that there may be special regulatory provisions in International Treaties that govern interactions with marine and coastal birds in the Beaufort Sea region. Lessees also are advised by this ITL that behavioral disturbance of most birds 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. If lessees and their contractors adhered to these recommendations it is unlikely that any of these species would experience significant disturbance effects, a definite benefit, particularly for populations of those species that declined severely in recent decades.

IV.C.6.b. Effects of Alternatives and Sales

IV.C.6.b(1) Effects of Alternative I for Sale 186

The effects of normal activities on marine and coastal birds under Alternative I for Sale 186 oil and gas exploration and development are likely to be about the same as those described in Section IV.C.6.a (Effects Common to All Alternatives). This is because although birds using the marine environment apparently are relatively abundant and, thus, vulnerable to disturbance or oil-spill contact in the central and western Beaufort Sea (Fischer, 2002; Fischer, Tiplady, and Larned, 2002), the general effects discussed above primarily would occur in the vicinity of central Beaufort primary support facilities where the Near and Midrange zones (Harrison Bay to Mikkelsen Bay, Map 4) are likely to contain 90% of the Sale 186 leasing activity and all three development projects (Table IV.A-4) and, thus, where most adverse effects are likely to occur. Fewer birds are likely to occur in the central offshore portions of the Far Zone, where only 10% of the leasing and exploration activity and no development projects are likely to occur as a result of this sale.

Potential effects include disruption of foraging or other activities, particularly in the vicinity of primary support facilities where converging support aircraft routes could cause more intensive disturbance than in distant (Far Zone) areas and, thus, displacement of birds from near helicopter- and vessel-traffic routes during construction and operational activities in the open-water season (Map 10a). Collision with offshore structures is likely to be the greatest source of mortality during normal operations. Brief disturbances (a few minutes to a few days) are not likely to have a significant effect on overall bird movements and distribution. However, recovery from any collision losses would not occur for species whose regional populations remain in a declining status (most currently are nonsignificant rates of decline).

In the unlikely event a large oil spill occurs under Alternative I for Sale 186, small to substantial numbers of birds could be killed. This could include 773-5,372 molting long-tailed ducks and, in areas east of Mikkelsen Bay, a spill could contact up to 23,600 individuals (Map 10b). Other species with smaller numbers dispersed in this area are likely to experience lower mortality from a spill, for example: 176 king eiders, 91 scoters, 568 common eiders, 487 glaucous gulls, and 17 Pacific loons. Mortality at the higher levels predicted by Fish and Wildlife Service data (Stehn and Platte, 2000) could result in significant effects for long-tailed ducks and king and common eiders. Recovery of losses would not occur for those species whose regional populations are in declining status. The probability of spill contact within 30 days in sea segments and other environmental resource areas that are contained within the spill launch areas most likely to contain development in Sale 186 ranges up to 55% for spill-launch areas and 64% for associated pipelines. These risk values are lower than those obtained if leasing occurred throughout the planning area with equal intensity. This is likely, because most leases and developments are likely to occur in the Near Zone (70% of leasing and two developments) or nearby portions of the Midrange Zone (20% and one development) close to centrally located primary support facilities in Deadhorse, rather than farther offshore or west where there are some environmental resource areas used by several marine and coastal species that have higher contact probabilities.

Conclusions. The effects from activities associated with Alternative I for Sale 186 include nonsignificant disturbance, and the potential loss of small numbers of birds from collision with structures. In the unlikely event a large oil spill occurs, the risk of contact is likely to be somewhat lower than if developments were spread throughout the planning area, which could include some areas used by marine and coastal birds that have higher contact probabilities indicated by the MMS oil-spill model. Recovery from substantial oil-spill mortality would not occur in any species whose population is in a declining status; however, determination of status may be obscured by natural variation in population numbers. Overall effects of an unlikely large oil spill could result in significant effects for long-tailed ducks and king and common eiders.

IV.C.6.b(2) Effects of Alternative I for Sale 195

The effects of normal activities marine and coastal birds under Alternative I for Sale 195 oil and gas exploration and development are likely to be about the same as those described in Section IV.C.6.a - Effects Common to All Alternatives, and somewhat less than under Sale 186. This is because although most species apparently are relatively abundant and, thus, vulnerable to disturbance or oil-spill contact in the central and western Beaufort Sea (Fischer, 2002), the general effects discussed primarily would occur in the vicinity of central Beaufort primary support facilities (Near and Midrange zones, Map 4) where 80% of the Sale 195 leasing activity and two development projects (Table IV.A-4) are likely to occur and, thus, where most adverse effects are likely to occur. The decrease from Sale 186 is because a large proportion of staging or migrating birds pass through the Near Zone where a lower proportion of the leasing and exploration, and just one development under Sale 195 as compared to two developments under Sale 186, are likely to occur. Similar intensity of lease activity and the same amount of development likely to be occurring in the Midrange Zone (Map 4) under the two sales probably would have little effect. Fewer birds and, thus, less chance of impacts, are likely to occur in the centrally located offshore portions of the Far Zone, where it is most likely a major proportion of the 20% of leasing and exploration activity and no development projects are likely to occur as a result of this sale.

Potential effects include disruption of foraging or other activities, particularly in the vicinity of primary support facilities where converging support aircraft routes could cause more intensive disturbance than in distant (Far Zone) areas and, thus, displacement of birds from near helicopter- and vessel-traffic routes during construction and operational activities in the open-water season. Collision with offshore structures is likely to be the greatest source of mortality during normal operations. Brief disturbances (a few minutes to a few days) are not likely to have a significant effect on marine and coastal bird movements and distribution. However, recovery from any collision losses would not occur for any regional populations that are in declining status (most species currently are increasing, stable or in non-significant decline).

In the unlikely event a large oil spill occurs under Alternative I for Sale 195, small to substantial numbers of several species could be killed, including an average of 773-5,372 molting long-tailed ducks; in areas east of Mikkelsen Bay a spill could contact up to 23,600 individuals (Stehn and Platte, 2000). Other species with smaller numbers dispersed in this area are likely to experience lower mortality from a spill, for example: 176 king eiders, 91 scoters, 568 common eiders, 487 glaucous gulls, and 17 Pacific loons. Mortality at the higher levels predicted by Fish and Wildlife Service data (Stehn and Platte, 2000) could result in significant effects for long-tailed ducks and king and common eiders. Recovery of losses would not occur for those species whose regional populations are in declining status. The environmental resource areas that occur within the spill-launch areas that are most likely to contain development under Sale 195 within 30 days is the same as for Sale 186. These risk values are lower than those obtained if leasing occurred throughout the planning area with equal intensity. This is a likely result, because most leases and developments are likely to occur in the Near Zone (50% of leasing and one development) or nearby portions of the Midrange Zone (20% and one development) close to centrally located primary support facilities in Deadhorse, rather than farther offshore or west in the vicinity of some areas with higher spill contact probabilities.

Conclusions. The effects from normal activities associated with Alternative I, Sale 195 include nonsignificant disturbance and the potential loss of small numbers of birds from collisions with structures. Disturbance of birds in the Near Zone is likely to be lower than under Sale 186, because a lower proportion of leasing and exploration is likely to occur there, while lease activity in the Midrange Zone is somewhat greater but the number of development projects is the same. In the event a large oil spill occurs, the risk of contact is likely to be somewhat lower under Sale 195 than under Sale 186, which proposes one more development project than Sale 195, or lower than if developments were spread throughout the planning area, which could include some areas used by several bird species that have higher spill-contact probabilities indicated by the MMS oil-spill model. Recovery from substantial oil spill mortality would not occur for any species whose population is in a declining status; however, determination of status may be obscured by natural variation in population numbers. Overall effects are likely to be somewhat less than those that could occur as a result of Sale 186 but still could result in significant effects for long-tailed ducks and king and common eiders.

IV.C.6.b(3) Effects of Alternative I for Sale 202

The effects of normal activities under Alternative I for Sale 202 oil and gas exploration and development on marine and coastal birds are likely to be considerably less than described for Sales 186 or 195. This is because although 30% of the leasing and exploration activity and the only development project are likely to occur in the Far Zone (Map 4), such activity is likely to take place offshore of the centrally located primary support facilities where relatively few birds are likely to consistently occur. The remainder of this zone lies from offshore Harrison Bay to Point Barrow, where several species may be relatively common (eiders, long-tailed ducks, Pacific loons) but leasing is less likely, because development sites would be far removed from industrial infrastructure.

Potential effects include disruption of foraging or other activities or displacement from within about 1-2 kilometers (0.62-1.2 miles) of helicopter routes to drill sites and vessel traffic during construction and operational activities in the open-water season. Collision with offshore structures is likely to be the greatest source of mortality during normal operations. Brief disturbances (a few minutes to a few days) are not likely to have a significant effect on bird movements and distribution. However, recovery from any collision losses would not occur for any regional population in declining status (most species currently are increasing, stable, or in nonsignificant decline).

In the unlikely event a large oil spill occurs under Alternative I for Sale 202, small numbers of a few species could be contacted and die, although the likely area of development (60% of leasing in the Midrange and Far zones, and just one development in the latter) is beyond the areas where most species would occur in abundance. Recovery of losses would not occur for any species whose population is in a declining status; however, determination of status may be obscured by natural variation in population numbers. Overall effects are likely to be considerably less than those that could occur as a result of Sales 186 or 195; however, under conditions favorable to an oil spill spreading toward the shore, they still may result in significant effects for long-tailed ducks and king and common eiders.

Conclusions. The effects from activities associated with Alternative I, Sale 202 include a small amount of nonsignificant disturbance, and the potential loss of small numbers of birds from collision with structures. The risk of oil-spill contact is relatively low, because only one development is likely, most likely located where most species are relatively scarce. Effects are likely to be considerably less than those that could occur as a result of Sales 186 or 195.

IV.C.6.b(4) Effects of Alternatives III, V, and VI for All Sales

Alternative III (Barrow Subsistence-Whaling Deferral) would defer leasing and development in some offshore and western Far Zone areas, where the probability of oil-spill contact within 30 days is relatively high and marine and coastal birds are known to occur. However, the likelihood that leasing and development would occur this far from primary support infrastructure is low under any of the three sale scenarios, and effects from normal activities or an oil spill under these alternatives are likely to be the same as under Alternative I for Sales 186, 195 and 202.

Alternatives V (Kaktovik Subsistence-Whaling Deferral) and VI (Eastern Deferral) would defer leasing and development in areas where most marine and coastal bird species are relatively less common than to the west. In addition, because these areas are relatively far removed from primary support facilities in the vicinity of Deadhorse, it is less likely that leasing and development would occur there than in the central Beaufort area. Effects from normal activities or an oil spill under these alternatives for any of the three sale scenarios are likely to be the same as under Alternative I for Sales 186, 195, and 202.

Conclusion: Because Alternatives III, V, and VI defer areas well removed from primary support facilities in the central Beaufort, where most leasing and development is likely to occur, effects from activities and any oil spill associated with any of the three sales on marine and coastal birds are likely to be the same as under Alternative I for Sales 186, 195, and 202.

IV.C.6.b(5) Effects of Alternative IV for All Sales

Alternative IV (Nuiqsut Subsistence-Whaling Deferral) would defer leasing and development in central Beaufort Sea areas, where several species of marine and coastal birds are relatively abundant during at least part of the open-water season. Aerial survey in this area suggest that in nearshore areas ranging approximately from 19-301 square kilometers, and an offshore area approximately 4,914 square kilometers in area, up to 17,497 long-tailed ducks, 6,201 king eiders, 1,075 common eiders, and 105 Pacific loons could be present (Stehn and Platte, 2000). Because these deferrals are likely to substantially lower the probability of oil contact in these areas in the unlikely event a large oil spill were to occur, the risk of contact and presumably the effects on these bird populations that could result are likely to be decreased substantially.

Conclusion. The effects from activities associated with Alternative IV on several bird species are likely to be somewhat less than under Alternative I for Sale 186; however, in the unlikely event a large oil spill occurs, effects on regional populations of several species could be lowered substantially.

IV.C.7. Marine Mammals (Pinnipeds, Polar Bears, and Beluga and Gray Whales)

Seven species of nonendangered marine mammals—ringed, spotted, and bearded seals; polar bears; walruses; and beluga and gray whales—commonly occur year-round or seasonally in a portion of or throughout the Beaufort Sea Planning Area. Some individuals of these species are likely to be exposed to some OCS exploration and development and production activities as a result of the proposed Sales (186, 195, and 202).

IV.C.7.a. Effects Common to All Alternatives

The following effects to marine mammals would be the same for all alternatives and sales and as the result of routine operations for exploration and development and production. Section IV.C.7.a(2) describes effects that might occur in the unlikely event of a large oil spill.

IV.C.7.a(1) Effects of Exploration

The effect of exploration would occur primarily from routine operations. The unlikely effects associated with a very unlikely very large oil spill (a blowout) are discussed in Section IV.I.2.g.

IV.C.7.a(1)(a) Effects of Noise and Disturbance from Routine Exploration Activities

The primary sources of noise and disturbance of ringed, bearded, and spotted seals; polar bears; and beluga and gray whales would come from the air and marine traffic associated with Beaufort Sea oil exploration. More specifically, sources would come from the supply boats, icebreakers, and helicopters associated with the assumed one to two exploration-drilling platforms per year. Secondary disturbance sources would be low-frequency noises from drilling operations on the one to two exploration-drilling rigs and nine production platforms (see Section IV.A.2 and 3 and Table IV.A.1-4). Aircraft traffic, about 140-155 helicopter round trips per year over a 2- to 4-year exploration period (140 in the Far Zone to 155 in the Near and Midrange zones), would be centered primarily out of Deadhorse-Prudhoe Bay, traveling to and from the one to two exploration platforms per year. This traffic is assumed to be a source of primary disturbance to some bearded and ringed seals hauled out on the ice and polar bears traveling on the ice within the planning area (Point Barrow east to Demarcation Bay). Some beluga and gray whales might be diverted by helicopter noise up to 100 meters away (Richardson et al., 1998). Such brief, occasional disturbances are not likely to have any serious consequences for these cetaceans (Richardson et al., 1991; 1998).

Some of the air traffic to and from the one to two exploration-drilling platforms (see Table IV.A.1) could disturb hauled-out seals and walruses, causing them to charge in panic into the water. Because of frequent low visibility due to fog, aircraft may not always be able to avoid disturbing seals and walruses hauled out on the ice. Aircraft disturbance of hauled out seals and walruses in the planning area could result in injury or death to some young seal pups and walrus calves. Although air-traffic disturbance would be very brief, the effect on individual seal pups and walrus calves could be severe, if the pups or calves were injured or abandoned by their mothers. The number of seals and walruses affected is expected to be small due to the low number of disturbance incidents expected under the proposed activities during exploration. Aircraft disturbance of small groups of spotted and ringed seals hauled out along the coast or disturbance of bearded and ringed seals hauled out offshore near the one or two drill platforms is expected to result in the death, injury, or abandonment of no more than small numbers (fewer than 10) of seals. Increases in physiological stress of adult or juvenile seals caused by the disturbance might reduce the longevity of some seals, if disturbances were frequent. However, the number of disturbances likely would be relatively infrequent, given that the helicopter flight paths will vary depending on the locations of the exploration platforms and the scattered distribution of seals and walruses in the planning area. During the beluga whale migration, some of the aircraft traffic over open-water ice leads temporarily may divert the migration movements of some beluga whales as the aircraft pass overhead or nearby, but these reactions are not likely to be biologically significant (Richardson et al., 1995b).

Boat traffic (between about 7 and 14 supply boat trips per year during exploration (see Table IV.A-4) could briefly (a few days) disturb some marine mammals within a lead system and may temporarily interrupt the movements of beluga and gray whales and seals or temporarily displace some animals when the vessels pass through the area. However, there is no evidence to indicate that vessel traffic would block or delay marine mammal migrations. In fact, severe ice conditions are likely to have a far greater influence on spring and fall migrations than vessel traffic associated with oil exploration. Such traffic is not likely to have more than a short-term (a few hours to a few days) effect on marine mammal movements or distributions; but the displacement of pinnipeds, polar bears, beluga and gray whales could affect the availability of these animals to subsistence hunters for that season. Icebreaker activity and offshore ice-road construction also physically might alter some ice habitats and destroy some ringed seal lairs in pack-ice areas, perhaps crushing or displacing some ringed seal pups and perhaps displacing some denning polar bears.

IV.C.7.a(1)(b) Effects of Seismic Activities

We assume that geophysical shallow-hazard surveys (162 square miles during exploration) would be shot over an estimated 7 days, primarily during the open-water seasons, using about two vessels per year (see Table IV.A-4). Geophysical site-clearance surveys for a block survey would occur during development in association with production-platform installation; and high-resolution seismic-survey lines are assumed to be run in association with the laying of about 115 miles of offshore pipelines under Alternative I for Sales 186, 195, and 202.

Ringed seals pupping in floating-shorefast-ice habitats within about 150 meters (490 feet) of the on-ice shot lines, and female polar bears that may be denning within a mile of the shot lines, could be disturbed by on-ice seismic exploration. However, the number of ringed seal pups and polar bears that possibly could be affected as a result of this very low level of disturbance is likely to be no more than a few hundred seals and a few bears, considering the low density of breeding seals and the dispersed distribution of denning polar beards in the Beaufort Sea, and would represent no more than a short-term (less than 1 year) effect on the seal and polar bear populations. Aerial surveys of ringed seals during the spring to monitor their distribution after winter ice road and seismic operations from 1997-1999 indicated no significant effect on ringed seal density (Moulton et al., 2002).

Similar to other boat traffic, open-water, active seismic activities are likely to result in startle responses by ringed, bearded, and spotted seals; polar bears; and beluga and gray whales near the sound source. The zone of influence is estimated to be within an area (out to 4.9 kilometers) where sound levels form seismic activities exceed 160 decibels (Harris, Miller, and Richardson, 2001). As with other vessel traffic, this disturbance response is likely to be brief; and the affected animals are likely to return to normal behavior patterns within a short period of time after a seismic vessel has left the area. If the presence of noise from industrial activity occurred very near coastal subsistence areas and reduced or delayed the use of these habitats by marine mammals, the availability of these subsistence resources to villagers could be adversely affected for that season (see Section IV.C.11 - Subsistence-Harvest Patterns).

IV.C.7.a(1)(c) Summary

The effect of exploration only is expected to be low, with only brief disturbances of small numbers of pinnipeds, polar bears, and beluga and gray whales from air and vessel traffic, with recovery from any disturbance event occurring within less than 1 day.

IV.C.7.a(2) Effects of Development

Noise and disturbance, alteration of habitats, and oil pollution during development could adversely affect some portion of these marine mammal populations found in the proposed Sale 186, 195, and 202 areas.

Traditional Knowledge on Disturbance of Seals and Polar Bears. Natives of the North Slope are concerned that noise heard miles away from drilling platforms may drive ringed and bearded seals away from subsistence-hunting areas (Philip Tikluk from the village of Kaktovik, as cited in Kruse et al., 1983). This may happen during construction when high levels of industrial activity occur. Thus, construction could displace some ringed and bearded seals for up to two seasons or 2 years within perhaps 1 kilometer of offshore pipeline and platform installation sites. However, the presence of exploration and production islands in the Beaufort Sea could result in the formation of leads and cracks in the ice on the leeward side of the island. Such local changes in the ice habitat after island construction is completed could attract seals that, in turn, could attract polar bears to the drilling platforms, as was reported in association with exploration gravel islands in the Canadian Beaufort Sea (Stirling, 1988).

Constructing gravel islands in the seals' ice habitats and breathing-hole ice habitats is a concern (Akootchook, 1986, pers. commun.).

IV.C.7.a(2)(a) Effects of Routine Operations

IV.C.7.a(2)(a)1) Effects of Noise and Disturbance

Airborne or underwater noise associated with OCS activities is the main source of disturbance of seals, walruses, polar bears, and gray and beluga whales.

IV.C.7.a(2)(a)1)a) Airborne Noise

Major sources of mobile airborne-noise disturbance are low-flying aircraft and high-speed motorboats and other high-frequency, high-pitched sounds. Low-flying aircraft are known to panic hauled-out seals and walruses (Johnson, 1977; Salter, 1979). If walrus nursery herds in the far western portion of the sale area are hauled out on the ice, disturbance may result in the death or injury of walrus calves from trampling by disturbed adults. If disturbance of hauled-out seals occurs frequently during molting, the successful regrowth of skin and hair cells may be retarded, increasing physiological stress on seals during a normally stressful period. Increases in physiological stress possibly could decrease fertility and longevity of affected seals. Aircraft-noise disturbance of beluga whales from flyovers generally is very transient, with events not lasting more than a few seconds (Stewart, Awbrey, and Evans, 1983). Belugas reacted to a low-flying (at an altitude of less than or equal to 250 meters [820 feet]) helicopter by diving, veering away, or showing other changes in behavior; however, most whales showed no obvious reaction to single passes of helicopters at altitudes greater than or equal to 150 meters (Richardson et al., 1995b). Such brief disturbances are not likely to have any serious consequences to beluga or gray whales.

Major stationary sources of airborne noise include construction of artificial islands and dredging and drilling operations. These activities may disturb hauled-out seals, walruses, and polar bears occurring within a few kilometers of the noise sources. However, underwater noises borne from these sources could influence marine mammals over a greater area. Land-based industrial activities and human presence near polar bear dens pose potentially serious disturbances. However, some denning polar bears tolerated ice-road traffic (400 meters away) and seismic testing as close as 135 meters from their dens (Amstrup, 1993). Only noise from seismic operations within 100 meters and a helicopter taking off within 3 meters of the den could be notably heard above background sounds within the den (Amstrup, 1993). Experience with captive female polar bears suggests that these bears can be especially sensitive to noise and human presence during maternity denning. Onshore seismic activities within 1.8 kilometers of a grizzly bear den caused changes in heart rate and movement of the female bear and cubs (Reynolds, Reynolds, and Follman, 1986). Human scent and other noises near maternity dens also may disturb the bears. The latter investigators suggest that seismic-testing activities within 200 meters of the den may cause abandonment of the den. If a female bear with cubs is forced to prematurely abandon a den, the survival of the cubs is likely to be low (Amstrup and Garner, 1994).

IV.C.7.a(2)(a)1)b) Underwater Noise

Sound is more efficiently transmitted and travels at a greater velocity in water than in air. Underwater sound-propagation loss is higher in shallow water than in deepwater (Greene, 1981). Bottom material, structures, and the undersurface of ice cover strongly influence sound transmission; and propagation of most sound frequencies is greater in summer than in winter in the Beaufort Sea (Greene, 1981). Mobile sources of industrial underwater noise primarily include support vessels, icebreakers, seismic boats, and aircraft; stationary sources include active dredges, drill rigs, drillships, and offshore-production and -processing facilities.

Underwater noise may alarm beluga whales and pinnipeds, causing them to flee the sound source. For example, Fraker, Sergeant, and Hoek (1978) reported the startled response and flight of beluga whales from barges and boats traveling through a whale-concentration area. In two documented cases, Finley and Davis (1984) reported strong fleeing reactions by beluga whales when icebreaker ships approached at distances of 35-50 kilometers. The whales were displaced or moved over 80 kilometers along the ice edge, or they stopped moving within 20 kilometers when they reached coastal waters (Finley and Davis, 1984). Stewart, Awbrey, and Evans (1983) reported that beluga whales responded to outboard-motor noises by immediately moving downriver away from the source; but whale exposure to playback recordings of drilling sound had little effect on the movement and general activity of the whales. Reactions of beluga whales or pinnipeds to noise sources, particularly mobile sources such as marine vessels, are likely to be highly variable depending on the animals' prior exposure to the disturbance source and their need to be in a particular habitat area where they are exposed to the noise and visual presence of the disturbance sources. For example, beluga whales foraging within the busy fishing grounds of Bristol Bay may be more tolerant of boat traffic, with shorter recovery times and shorter displacement distances from passing fishing vessels, than migrating belugas that reacted to icebreaker traffic in Lancaster Sound (located between Baffin and Devon islands in the Canadian arctic islands), as reported by Finley and Davis (1984). The latter whales may be "naïve" with respect to vessel noise (Finley and Davis, 1984).

Because vocalizations are an important source of communication between mother and pups in pinnipeds, underwater noise may interfere with or mask reception of marine mammal communication (Perry and Renouf, 1987), or it may interfere with the reception of other environmental sounds used by marine mammals for navigation (Terhune, 1981). Noise produced by outboard motors operating at high speeds may have the greatest potential for interfering with beluga whale communication and some echolocation signals (Stewart, Awbrey, and Evans, 1983), but exposure to this interference source is likely to be very transient. Low-frequency noises from drilling platforms would not mask the high-frequency echolocation signals of beluga or other toothed whales (Gales, 1982). Theoretically, very noisy drilling platforms may slightly mask low-frequency whale sounds out to a range of 35 miles (56 kilometers), but the possible masking range more likely would be limited to about 3 miles (4.8 kilometers) (Gales, 1982). If the distance between communicating whales does not exceed their distance from the platforms, no appreciable interference is likely to occur (Gales, 1982).

Experiments exposing captive beluga whales to recorded drilling sounds suggest that whales can acclimate quickly to typical oil-drilling sound levels (Aubrey et al., 1984). Informal observations of beluga whales near drilling platforms in Cook Inlet support this suggestion (McCarty, 1981). Beluga whales did not react to recorded drilling noise in the Beaufort Sea at distances greater than 200-400 meters, even though the projected drilling noise was measurable up to several kilometers away ((Richardson et al., 1995b). At distances beyond 200 meters, received levels of low-frequency drilling sounds usually were less than the measured hearing sensitivity of beluga whales. The potential beluga and gray whale disturbance radius used for monitoring industrial noise associated with construction of the Northstar oil development was 1-2 kilometers (Richardson and Williams, 2001).

Received noise levels associated with nearshore (25 kilometers of the shore) open-water geophysical seismic activities in the Beaufort Sea in 1998 diminished below 160 decibels (ambient noise levels) at distances less than 4 kilometers (Richardson, 1999). The operation of a seismic airgun array had effects on the distribution and the behavior of some ringed, bearded, and spotted seals within a few hundred meters of the array (Richardson, 1999).

Intense noise could damage the hearing of marine mammals or cause other physical or physiological harm (Geraci and St. Aubin, 1980; Hill, 1978). Probably the most intense noise that was associated with offshore industrial activity was the use of explosives in seismic-survey work (no longer used in seismic exploration). The sound pressure from these sources is very high and might physically injure or kill marine mammals near the explosion site. However, if spherical spreading of sound pressure is assumed, the pressure would fall below a harmful level at 2,752 meters (3,000 yards) from the source, and nonauditory effects would be unlikely (Gales, 1982). Loss of hearing or auditory discomfort still may occur at greater distances from this potential noise source. Noise levels measured from various existing drilling platforms generally are well below a level of high marine mammal sensitivity for toothed cetaceans such as beluga whales (Greene, 1986) and pinnipeds such as harbor seals at a distance of 15 meters from the platform (Gales, 1982). This information suggests that drilling operations are not likely to cause any annoyance to nonendangered cetaceans and pinnipeds except perhaps to individuals passing very close to the platforms. The playback of recorded industrial noises in the presence of breeding ringed seals indicated no effect or no reduction in ringed seal vocalizations or other sounds made by the seals (Cummings, Holliday, and Lee, 1984). The noise associated with construction of a gravel island in shallow water could not be detected at 2 miles (3.2 kilometers) from the island (Greene and Johnson, 1983), and ringed seal distribution was slightly altered in the immediate vicinity of the island (Green and Johnson, 1983).

Frequent and/or intense noise that causes a flight or avoidance response in marine mammals permanently could displace animals from important habitat areas. However, the monitoring of beluga behavior and distribution for the past 10 years in the Mackenzie River Delta estuary (in association with marine traffic supporting Canadian oil and gas activities) has not shown any long-term or permanent displacement from the estuary, even with comparatively high levels of industrial activity (Fraker, 1983). The presence of several thousand beluga whales, seals, and walruses in Bristol Bay during intensive commercial-fishing activity and their exposure to noise from numerous fishing boats suggests that these species and perhaps other marine mammals can habituate to fairly high levels of human activity.

Noise could cause disruption of reproductive activities such as displacement of ringed seals from important denning and pupping habitats. A comparison of ringed seal densities between areas of seismic exploration and areas where no on-ice seismic activities occurred (using aerial data collected in June 1975-1977 to investigate variation in ringed seal distribution) showed a lower density of seals in areas where there had been seismic exploratory activity (Burns, Shapiro, and Fay, 1980). However, such survey data are an indication only of overall survival through the long winter-spring period and provide no insight into the nature, extent, or causes of changes recorded (Burns and Kelly, 1982). Burns and Kelly (1982) conducted ground examination of ringed seal-den structures to determine the fate of such structures along seismic lines and along control lines. The latter investigators reported no significant overall difference in the fates of den structures between seismic and control lines; however, they reported significant differences in the fates of den structures in relation to distance from seismic lines (within 150 meters of the shot line in comparison to beyond this distance). The investigators concluded that displacement of seals in close proximity (within 150 meters) to seismic lines does occur. However, based on data from aerial surveys in 1982, there is no large-scale displacement of seals away from on-ice seismic operations as currently conducted in the Beaufort Sea. Aerial surveys conducted in 1985 and 1986 along the Beaufort Sea coast also indicated no large-scale displacement of ringed seals from industrialized areas (Frost et al., 1988).

IV.C.7.a(2)(a)1)c) Beaufort Sea Planning Area Specific Effects of Noise

The primary sources of noise and disturbance of ringed, bearded, and spotted seals; polar bears; and beluga and gray whales would come from the air and marine traffic associated with Beaufort Sea oil development. More specifically, sources would come from the supply boats, icebreakers, and helicopters associated with the nine production platforms under the assumed three sales in the Beaufort Sea Planning Area. Secondary disturbance sources would be low-frequency noises from drilling operations on nine production platforms (see Sections IV.A.2 and 3 and Tables IV.A.1-4). Aircraft traffic, about 300-600 round-trips per month during construction, 28-56 during development, and 12-28 during production, would be centered primarily out of Deadhorse-Prudhoe Bay, traveling to and from eight production platforms. This traffic is assumed to be a source of primary disturbance to some bearded and ringed seals hauled out on the ice and polar bears traveling on the ice within the planning area (Point Barrow east to Demarcation Bay). Some beluga and gray whales might be diverted by helicopter noise up to 100 meters away (Richardson et al., 1995b). Such brief, occasional disturbances are not likely to have any serious consequences for these cetaceans (Richardson et al., 1991; 1995b).

Some of the air traffic to and from the eight production platforms (see Table IV.A.1) could disturb hauled-out seals and walruses, causing them to charge in panic into the water. Because of frequent low visibility due to fog, aircraft may not always be able to avoid disturbing seals and walruses hauled out on the ice. Aircraft disturbance of hauled out seals and walruses in the planning area could result in injury or death to some young seal pups and walruses calves. Although air-traffic disturbance would be very brief, the effect on individual seal pups and walrus calves could be severe, if the pups or calves were injured or abandoned by their mothers. The number of seals and walruses affected is expected to be small due to the low number of disturbance incidents expected under the proposed activities development. Increases in physiological stress of adult or juvenile seals caused by the disturbance might reduce the longevity of some seals, if disturbances were frequent. However, the number of disturbances likely would be relatively infrequent, given that the helicopter flight paths will vary depending on the locations of the eight platforms and the scattered distribution of seals and walruses in the planning area. During the beluga whale migration, some of the aircraft traffic over open-water ice leads temporarily may divert the migration movements of some beluga whales as the aircraft pass overhead or nearby, but these reactions likely would not be biologically significant (Richardson et al., 1995b).

It is possible that some polar bears could be unavoidably killed to protect oil workers, when the bears were attracted to the rigs due to food odors and curiosity. Under the Marine Mammal Protection Act, oil companies are required to have a permit to take or harass polar bears. Consultation between the companies and the Fish and Wildlife Service on this matter is expected to result in the use of nonlethal means in most cases to protect the rig workers from polar bear encounters. The number of bears lost as a result of such encounters is expected to be very low (such as fewer than 10 bears "taken") over the life of the oil fields in the Beaufort Sea.

Boat traffic or icebreakers (for offshore platforms in the Far Zone) could briefly (a few days) disturb some marine mammals within a lead system and may temporarily interrupt the movements of beluga and gray whales and seals or temporarily displace some animals when the vessels pass through the area. However, there is no evidence to indicate that vessel traffic would block or delay marine mammal migrations. In fact, severe ice conditions are likely to have a far greater influence on spring and fall migrations than vessel traffic associated with oil exploration and development. Such traffic is not likely to have more than a short-term (a few hours to a few days) effect on marine mammal movements or distributions; but the displacement of pinnipeds, polar bears, beluga and gray whales could affect the availability of these animals to subsistence hunters for that season. Icebreaker activity and offshore ice-road construction also physically might alter some ice habitats and destroy some ringed seal lairs in pack-ice areas, perhaps crushing or displacing some ringed seal pups and perhaps displacing some denning polar bears.

IV.C.7.a(2)(a)1)d) Effects of Seismic Activities

We assume that geophysical shallow-hazard surveys (162 square miles during exploration and 280 square miles during development) would be shot over an estimated 7 days, primarily during the open-water seasons, using about two vessels per year (see Table IV.A-4). Geophysical site-clearance surveys for a block survey would occur during development in association with production-platform installation; and high-resolution seismic-survey lines are assumed to be run in association with the laying of about 115 miles of offshore pipelines under Alternative I for Sales 186, 195, and 202.

Ringed seals pupping in floating-shorefast-ice habitats within about 150 meters (490 feet) of the on-ice shot lines could be disturbed by on-ice seismic exploration. However, the number of ringed seal pups that possibly could be affected as a result of this very low level of disturbance is likely to be no more than a few hundred, considering the low density of breeding seals in the Beaufort Sea, and would represent no more than a short-term (less than 1 year) effect on the population. During development, an estimated 280 square miles of open-water shallow-hazard survey lines at (eight platforms) survey sites (based on past seismic activity), using perhaps one or two seismic vessels for 7 days, could disturb some pinnipeds, polar bears, and beluga whales during the days of survey activity.

Similar to other boat traffic, open-water, active seismic activities are likely to result in startle responses by ringed, bearded, and spotted seals; polar bears; and beluga and gray whales near the sound source. The zone of influence is estimated to be within an area (out to 4.9 kilometers) where sound levels form seismic activities exceed 160 decibels (Harris, Miller, and Richardson, 2001). As with other vessel traffic, this disturbance response is likely to be brief; and the affected animals are likely to return to normal behavior patterns within a short period of time after a seismic vessel has left the area. If the presence of noise from industrial activity occurred very near coastal subsistence areas and reduced or delayed the use of these habitats by marine mammals, the availability of these subsistence resources to villagers could be adversely affected for that season (see Section IV.C.11 - Subsistence-Harvest Patterns). Overall, noise and disturbance from air and marine traffic associated with exploration only and the development in the planning area likely would have short-term (a few minutes to a few hours) local effects on marine mammal populations.

IV.C.7.a(2)(a)1)e) Effects of Offshore Construction

Under the assumed development scenario, one to two exploration-drilling units per year and the eight oil-production platforms are assumed under the three sales in the Beaufort Sea Planning Area (see Table IV.A-4). Platform-site preparation and pipeline trenching along the assumed 115 miles of offshore pipelines (80 miles in the Near and Midrange zones and 35 miles in the Far Zone) could affect marine mammals through noise and disturbances, alterations (a few square kilometers) of benthic habitat (representing less than 1% of the benthic habitat in the planning area affected by pipeline trenching), and temporary changes in the availability of food sources within this area. Some pinnipeds, polar bears, and beluga and gray whales could be temporarily displaced by noise and disturbance from platform-installation and pipelaying activities and also from other support activities. Temporary displacement could occur within about 2-3 kilometers of the following eight production platforms and pipeline-trenching locations: three projects in the Near Zone, two projects in the Midrange Zone, and one project in the Far Zone (Map 4). Prey species could be temporarily disrupted or buried near the pipeline-trenching and platform-preparation sites. Noise disturbance and adverse habitat effects associated with platform and offshore-pipeline installation likely would be very local (within a few kilometers or less of the platforms) and not affect marine mammal populations.

IV.C.7.a(2)(a)1)f) Effects of Onshore Construction

Landfalls are assumed to be developed for the offshore pipelines to the existing facilities under the assumed Sales 186 and 195 in the Beaufort Sea. These landfalls are assumed to be at either Oliktok Point, Northstar landfall, West Dock, or the Badami Field for Near Zone development (Figure III.A-1); additional landfalls at either Bullen Point and Point Thomson for Midrange Zone development and potential Far Zone development landfalls at either Smith Bay for a western Beaufort Sea discovery or Point Thomson for an eastern Beaufort Sea discovery. Either of the latter landfalls is assumed to occur under Sale 202 (Map 1) with the construction of 12- and 50-mile long elevated onshore pipelines to the existing pipeline facilities (see Table IV.A-4). During construction activities associated with Beaufort Sea development, a small number of seals and polar bears located within a few kilometers of the landfall sites could be disturbed and perhaps displaced. However, the number of animals disturbed and/or displaced would be few, and the amount of coastal habitat altered would be localized near the pipeline-landfall site. Onshore-development effects on regional marine mammal populations likely would be short-term (1 year or season) and local (1-3 kilometers [0.62-1.9 miles] from activity), with any disturbance of seals and polar bears declining after construction activities are complete.

IV.C.7.a(2)(b) Effects of a Large Oil Spill

Traditional Knowledge on Oil-Spill Effects on Seals and Polar Bears. In an interview in 1978, Thomas Brower, Sr. (as cited in U.S. Army Corps of Engineers, 1998), gave an account of a 25,000-gallon (6,000-barrel) oil spill and its effects at Elson Lagoon in 1944. He saw birds and seals that were blinded and suffocating from the oil in the water. It took about 4 years for the oil to disappear and, during that time, whales avoided passing near the lagoon during their fall migration.

IV.C.7.a(2)(b)1) General Effects of Oil Pollution

See OCS Reports MMS 85-0031 and MMS 92-0012 (Hansen, 1985; 1992) and the Sale 144 final EIS (USDOI, MMS, 1996a) for detailed discussions of the various possible direct and indirect effects of oil and other chemical pollutants on marine mammals.

IV.C.7.a(2)(b)1)a) Direct Effects of Oil

Direct contact with spilled oil may kill some marine mammals and have no apparent effect on others, depending on factors such as the species involved and the animals' age and physiological status. Some polar bears and newly born seal pups occurring in the sale area are likely to suffer direct mortality from oiling through loss of thermoinsulation, which could result in hypothermia. Adult ringed, spotted, and bearded seals and walruses are likely to suffer some temporary adverse effects such as eye and skin irritation with possible infection. Such effects may increase physiological stress and perhaps contribute to the death of some individuals (Geraci and Smith, 1976; Geraci and St. Aubin, 1980; Hansen, 1985, 1992). Deaths attributable to oil contamination are more likely to occur during periods of natural stress such as during molting or times of food scarcity and disease infestations. In case histories, the few recorded mammal deaths attributed to oil spills occurred during winter months (Duval, Martin, and Fink, 1981), a season of increased natural stress.

Although species-specific effects of oil contact on beluga whales have not been conducted, studies of hydrocarbon effects on dolphins and porpoises as representative odontocetes by Geraci and St. Aubin (1982) provide sufficient insight on potential effects of oil-spill contact on belugas. The findings of these experiments suggest that smooth-skinned cetaceans such as beluga whales, dolphins, porpoises, and killer whales could suffer some minor skin damage if they were confined to a small surface area contaminated with oil (such as an ice lead). However, such effects on the skin are likely to be short term or transient (oil is unlikely to adhere to the skin), with recovery occurring within a few days (Hansen, 1985, 1992).

Oil ingestion by marine mammals through consumption of contaminated prey and by grooming or nursing could have pathological effects, depending on the amount ingested, species involved, and the animal's physiological state. Death would be likely to occur if a large amount of oil were ingested or if oil were aspirated into the lungs. Ingestion of sublethal amounts of oil can have various physiological effects on a marine mammal, depending on whether the animal is able to excrete and/or detoxify the hydrocarbons. Geraci and Smith (1976) demonstrated that seals are able to excrete as well as absorb oil. Both seals and cetaceans potentially can metabolize oil through the function of an oxygenase enzyme complement (Engelhardt, 1983) demonstrated as cytochrome p-450 in the liver of cetaceans (Geraci and St. Aubin, 1982) and as aryl hydroxylase in the liver and kidney tissues of seals (Engelhardt, 1983).

Oil-Spill Avoidance. Seals, walruses, polar bears, and beluga whales are not likely to avoid oil spills intentionally, although they may limit or avoid further contact with oil if they experience discomfort or apprehension as a result of contact with an oil slick (Hansen, 1985, 1992). Under some circumstances, they may be attracted to the spill site if concentrations of food organisms are near by, or they may have little choice but to move through the spill site during migration.

IV.C.7.a(2)(b)1)b) Indirect Effects of Oil

Indirect effects of oil pollution on seals, walruses, polar bears, and beluga and gray whales would be those associated with changes in availability or suitability of various food sources. The arctic marine ecosystem consists of a relatively simple food web with top-level consumers such as ringed seals, beluga whales, and marine birds feeding primarily on a few species of abundant invertebrates and arctic cod. During heavy ice years, primary productivity is comparatively low, and food could be a limiting factor for large areas of the Beaufort Sea (Frost and Lowry, 1981).

If a major spill occurred during such a heavy ice year, the short-term loss of plankton and benthic invertebrates could locally reduce marine mammal food sources during a critical period and result in local decreased productivity of breeding ringed seals. The local reduction in ringed seal numbers as a result of direct or indirect effects of oil could, in turn, affect polar bear distribution.

However, ringed, spotted, and bearded seals; walruses; and beluga whales opportunistically prey on a variety of available food organisms and are quite capable of moving from an area of local prey depletion to other locations of prey abundance. Breeding ringed seals that remain in local areas during the pupping season may be an exception, but the reduction of food organisms would persist for no more than one season due to the rapid recruitment of the food organisms and would represent a short-term effect.

IV.C.7.a(2)(b)2) Specific Effects of a Large Oil Spill

Oil-spill contact and probabilities referred to in this section assume the occurrence of development to the extent estimated in Section II and the associated spill rates under the assumed three sales in the Beaufort Sea Planning Area (Section IV.A). Most attention is devoted to potential spills greater than or equal to 1,000 barrels that have a trajectory period of up to 30 days during the open-water period and up to 180 days after meltout during spring. The mean number of one (1,500 or 4,600 barrels) or more oil spills greater than or equal to 1,000 barrels occurring during development is 0.11. The most likely number of spills greater than or equal to 1,000 barrels is zero.

Assuming a spill occurs, marine mammal offshore habitats from about Point Barrow (Ice/Sea Segment 29) east to about Barter Island (Ice/Sea Segments 30-35) have a less than 0.5-35% chance of contact within 3 days during the summer open-water season (July 1 through September 30) (Table A.2-19; Maps A-4a and

4b). The highest chance (35%) of contact is to habitats offshore of about the Colville River east to offshore of Prudhoe Bay (ERA 32) (Table A.2-19). The highest winter (October 1 through June 30) conditional probabilities of spill contact to the spring ice lead system (Ice Segments 24-28) varies between 14-26% for spills assumed to occur within the planning area and contact occurring within 3 days (Table A.2-37, Maps A-4a and 4b). Coastline habitats from Dease Inlet, Cape Simpson east to Atigaru Point-Kogru River (Land Segments 26, 28-33, and 47), and the Kaktovik area (Land Segment 74) have the highest chance of contact, greater than 15% up to 21% from either LA1-LA18 or P1-P13, assuming spills occur during the summer season and contact the coastline within 30 days (Table A.2-27). Thus, polar bears and seals frequenting these coastal habitats have the highest chance of exposure to potential oil spills that contact the shoreline of the Beaufort Sea Planning Area. Winter spills that occur nearshore within the 20-meter isobath fast-ice zone are likely to affect some pupping and breeding ringed seals. Spills that occur in October are not likely to be cleaned up effectively under freezeup conditions and may contaminate fast-ice habitats of ringed seals. However, once freezeup occurs in the fast-ice zone, little spill movement or oil spreading would occur under the fast ice. The number of ringed seal pups and adult seals contaminated is likely to be small (2-3 seals per square kilometer in fast ice or perhaps 50-100 seals total loss). If an oil spill (1,500-4,600 barrels) occurred during the open-water period or occurred during winter and contacted the offshore flaw zone, larger numbers of ringed and bearded seals might be contaminated. Aggregations of hundreds of seals do occur in open water. Such an event could result in the contamination and loss of perhaps 100-200 seals.

In the unlikely event that a crude oil spill occurred in October, it is not likely to be effectively cleaned up under freezeup conditions and might contaminate the fast-ice habitats. However, once freezeup occurs in the fast-ice zone, the oil would spread very little under fast ice. A winter spill that occurred nearshore (within the 20-meter isobath fast-ice zone) would affect very few ringed seals during the pupping and breeding season, because the spill would cover only a few acres or less than 1 square kilometer under the ice (Tables IV.A-6a and IV.A-6b). If the spill occurred during broken ice or meltout (1,500-4600-barrels), it is assumed it would spread as a discontinuous slick over 143-252 square kilometers (Tables IV.A-6a and IV.A-6b). This spill could affect about 116-204 ringed seals, based on a spring density of about 0.81 seals per square kilometer (Frost et al., 1998) times the area swept by the spill (181-320 square kilometers). During the open-water summer season, a crude oil spill of 1,500-4,600 barrels could sweep over 181-320 square kilometers in 30 days (Tables IV.A-6a and IV.A-6b). The number of ringed seal pups and adults contaminated is likely to be small. If a 1,500-4,600-barrel crude oil spill were released during spring meltout or in broken ice and contacted the offshore flaw zone, more ringed and bearded seals could be contaminated, because hundreds of them sometimes do aggregate in ice leads or open water. Such an event could contaminate and kill up to perhaps 100-200 ringed seals but probably fewer than 10-20 spotted and 30-50 bearded seals, small numbers (fewer than 100) of walruses, and fewer than 10 beluga and gray whales (which have a much lower density than ringed seals in the planning area).

The net westward movement of spills and the chance of spill contact to offshore primary feeding habitats of gray whales and walruses during the summer open-water season (July 1 through October 1) is low, less than 0.5-6%, assuming spills occur in the planning area and contact Ice/Sea Segments 46-51 within 180 days or less (Table A.2-23). Oil contamination of walruses or gray whales probably would not result in direct mortality of healthy individuals. However, contamination seriously could stress diseased or injured animals and stress young calves, causing some deaths. Perhaps a small number of walrus calves (fewer than 100), gray whale calves (fewer than 10), and some adults could die from oil contamination, but such a loss is likely to be replaced within 1 year by natural recruitment in the population. Little or no significant contamination of benthic food organisms and bottom-feeding habitats of walruses, bearded seals, and gray whales is expected, because the fraction of the spill (such as 1-5%) is expected to be widely dispersed in the water column and to be weathered and degraded by bacteria before sinking to the bottom as scattered tarballs (see Section IV.A.4 - Spilled Oil Fate and Behavior in Marine Waters). The amount of benthic prey killed or contaminated by scattered tarballs from the spill that is 30 days old or more is likely to be very small and represent an insignificant proportion of the prey and benthic habitat available in the western Beaufort and eastern Chukchi seas.

Polar bears would be most vulnerable to oil-spill contamination along the ice-flaw zone north of Point Barrow east to Demarcation Bay (Ice/Sea Segments 24-37 and 52-58, respectively). However, the number of bears likely to be contaminated or indirectly affected by local reduction in seals as a result of an oil spill probably would be small considering the approximate density of one bear per 25 square kilometers (Amstrup, Durner, and McDonald, 2000). In a severe situation where a concentration of perhaps 20 or 30 bears were contaminated by an oil spill and assuming all the bears died, this one-time loss is not likely to affect the Beaufort Sea population of polar bears; annual recruitment probably would replace lost bears within 1 year up to more than one generation (7-10 years).

Polar bears are most likely to be oiled or eat oiled prey at a whale carcass on either Cross or Barter Island or at a concentration of seals in the sale area. Perhaps an estimated 5-30 bears may be harmed. This estimate is based on the number of polar bears sometimes observed by the bowhead whale aerial surveys conducted in the Cross and Barter islands areas during the fall Bowhead whale harvest (Treacy, 1988 through 1997). An estimated 5-30 bears could be lost to a spill, if the spill contacted Cross or Barter island when and where that many polar bears may be concentrated during the subsistence-whale harvest. This represents a severe event. However, the probability of this occurrence is low (for example, there is only a 2% conditional annual probability of a spill starting at area offshore Point Thompson or along the pipeline and contacting either the Cross or Barter island environmental resource areas within 30 days (Tables A.2-39 and Maps A-3a and 3b). The more likely loss would be no more than 6-10 bears (5.7-10 bears, assuming a bear density of 1 bear per 25 square kilometers [Amstrup, Durner, and McDonald; 2000] divided into 143-252 square kilometers, the area swept by the 1,500- to 4,600-barrel spill as a discontinuous slick in broken ice or meltout; Table IV.A-6a). The seal, walrus, beluga whale, and polar bear populations are expected to recover individuals killed by the spill within 1 year, and there would be no effect on the population.

Beluga whales would be most vulnerable to oil contact during the spring migration off Point Barrow. Contamination of the ice-lead system from an oil slick during spring migration (April-June) could directly expose several whales to some oil-spill contact. However, such contact is expected to be brief or intermittent and probably would not result in any deaths of healthy whales or have long-lasting sublethal effects after short exposure. The probability of oil-spill occurrence and contact to the lead system (Johnson et al., 2002; Table A.2-22,) during the spring (May-June) period is very low(less than 0.5%). The likely physical reaction between oil, ice, water temperature, and wind off Point Barrow appreciably would reduce the chance of an oil slick persisting in the lead system (Sackinger, Weller, and Zimmerman, 1983). Therefore, belugas of the western Beaufort population may have some contact with an oil spill (hydrocarbons in the water column or on the surface) that would temporarily contaminate the lead system off Point Barrow; however, few, if any, beluga whales are likely to be seriously affected, even in a severe situation, with no long-term effect on the population.

Over the production life of the multiple sales, 82 small crude oil spills (3 barrels) and 157-202 small refined oil spill (average of 0.7 barrels) are estimated to occur (Tables A-6a and A-6e). These minor spills could be expected to have an additive effect on seal, walrus, and polar bear losses, perhaps increasing losses by a few polar bears, seals, and walrus pups and increasing habitat contamination by perhaps about 1-2%. These small spills are not expected to affect beluga and gray whales that generally occur further offshore in the Beaufort Sea Planning Area.

IV.C.7.a(2)(b)3) Effects of Oil-Spill Cleanup

If a large spill were to oil habitats along the Beaufort Sea coast containing several hundred seals and some polar bears during the spring or open-water season, the hundreds of people, many boats, and several aircraft operating in the area for cleanup probably would displace some seals, walruses, beluga whales, and polar bears from oiled areas and temporarily stress others. It is possible that cleanup operations could displace some bears and ringed seals from maternity dens during the winter, resulting in the loss of a few bear cubs and seal and walrus pups. These effects may occur during 1 or 2 years of cleanup; however, we do not expect it to greatly affect seal, walrus, beluga whale, and polar bear behavior and movement beyond the area or after cleanup.

Cleanup efforts should include the removal of all oiled animal carcasses to prevent polar bears from scavenging on them. Oil-spill-contingency measures that include the aircraft hazing of wildlife away from the oil spill could reduce the chances of polar bears entering coastal waters where there is an oil slick. However, such hazing may have to be repeated to prevent polar bears from entering the oiled water or oiled shoreline area after the aircraft has left. Poor weather conditions would prevent this contingency measure from being effective.

The Alaska Clean Seas tactics (Alaska Clean Seas, 1998) for responding to spills in broken ice and pack ice could help, including the strategies for tracking oil in pack ice (Tactics T-1, -3, and -5) and the in situ burning of oil on ice (Tactics B-4, -5, and -6). However, poor weather conditions would prevent this contingency measure from being effective. The response plan discusses the importance of timely salvage of oiled carcasses and the required State and Federal permits (Tactics W-1 and -4).

Effects of Disturbance from Oil-Spill Cleanup. In the event of a large oil spill contacting and extensively oiling coastal habitats, the presence of several hundred humans, many boats, and several aircraft operating in the area involved in cleanup activities is expected to cause displacement of seals, polar bears, and other marine mammals in the oiled areas and to contribute to increased stress and reduced pup survival of ringed seals, if operations occur during the spring. This effect is expected to persist for perhaps 1 or 2 years and to affect seals, polar bears, and other marine mammals within about 1.6 kilometers (1 mile) of the activity.

IV.C.7.a(2)(c) Summary of Effects Common to All Alternatives

IV.C.7.a(2)(c)1) Effects of Noise, Disturbance, and Habitat Alteration

For Beaufort Sea oil and gas exploration and development, noise and disturbance and habitat alterations from drill-platform installation, pipeline laying, and other construction and oil spills could have some adverse effects on pinnipeds, polar bears, and beluga whales found in the sale area. Scientific and local Native knowledge of the behavior of nonendangered marine mammals and the nature of noise associated with offshore oil and gas activities suggest that intense noise causes startle, annoyance, and/or flight responses of pinnipeds, polar bears, and beluga whales. Helicopter trips and supply-boat traffic to and from the one or two exploration-drilling units and the three to five production platforms could disturb some hauled out ringed, bearded, and spotted seals, and may cause them to panic and charge into the water, which could result in perhaps the injury, death, or abandonment of small numbers of seal pups and walrus calves. Because nursing seals and pups are widely distributed along the ice front, aircraft moving to and from drill platforms are likely to temporarily disturb only a small portion of the seal and walrus populations. Thus, aircraft disturbance of seals, walruses, and polar bears is likely to cause short-term displacement (a few minutes to less than a few days) of small numbers of these animals (less than a few hundred) within about 1 kilometer of the air-traffic route. Vessel traffic (7-14 trips per year) associated with the 1-2 exploration-drilling units per year and eight production platforms and seismic vessels operating during the open-water season temporarily could displace or interfere with marine mammal movements and change local distribution for a few hours to a few days. Such short-duration and local displacement (within 1-3 kilometers [0.62-1.9 miles] of the traffic) likely would not affect the overall distribution of pinnipeds, polar bears, and beluga whales. The installation of eight production platforms and the laying of 115 miles of offshore pipelines within a few square kilometers of benthic habitat likely would have a short-term and local effect on a few of these marine mammals.

IV.C.7.a(2)(c)2) Effects of Large Oil Spill

The mean number of one (1,500 or 4,600 barrels) or more oil spills greater than or equal to 1,000 barrels occurring during exploration and development is 0.11. The most likely number of spills greater than or equal to 1,000 barrels is zero. In the unlikely event of an oil spill, the spill poses the greatest risk of contact (35%) to all marine mammals in habitats offshore of the Colville River east to offshore of Prudhoe Bay (Table A.2-19, Ice Segment 32). The highest winter (October 1 through June 30) conditional probabilities of spill contact to the spring ice-lead system (Ice Segments 24-28) varies between 14% and 26% for spills assumed to occur within the planning area and contacts occurring within 3 days (Table A.2-37, Maps A-4a and A-4b). Coastline habitats from Dease Inlet, Cape Simpson east to Atigaru Point-Kogru River (Land Segments 26, 28-33, and 47), and the Kaktovik area (Land Segment 74) have the highest risks of spill contact, greater than 15% up to 21% from either LA1-LA18 or P1-P13, assuming spills occur during the summer season and contact the coastline within 30 days (Table A.2-27). Some aggregations of perhaps 100-200 ringed, 10-20 spotted, 30-50 bearded seals, and small numbers of walruses (fewer than 100) and beluga and gray whales (fewer than 10) occurring in these habitats could be contaminated and suffer lethal or sublethal effects. Polar bears also would be most vulnerable to oil spills in the ice-flaw zone; however, a small number of bears (6-10) are likely to be affected because of their sparse distribution, with recovery taking place within 1 year.

Walrus herds and their seasonal feeding habitat west and north of Point Barrow are at a very low risk of oil-spill contact (less than 0.05%). If a spill contacts this area, direct effects of oil are likely to include the loss of some walrus calves and highly stressed adults. Such a loss is likely to be replaced by natural recruitment within less than 1 year. Little or no significant contamination of benthic food sources of walruses and bearded seals is expected, because very little oil is likely to sink to the bottom except for scattered tarballs. This contamination is not expected to reduce the availability of benthic organisms.

Beluga whales are most vulnerable to oil-spill contact during the spring migration off Point Barrow. Some belugas could contact hydrocarbons in the water column or on the surface if an oil spill contaminated the lead system off Point Barrow during spring migration. However, few (fewer than 10) beluga whales are likely to be seriously affected by probable brief exposure to the spill, with population recovery taking place within 1 year.

Gray whales are most vulnerable to oil spills that contact feeding habitats west and south of Point Barrow. The low probabilities of spill contact with this area suggest that few (fewer than 10) gray whales are likely to come in contact with oil from a spill in the sale area or be affected by oil contamination of benthic feeding habitat. The number of gray whales likely to be adversely affected by oil contamination would be few and oil would not affect the population that ranges primarily in the Chukchi Sea during the open-water season.

These losses would represent no more than a short-term (1-year) effect on the Beaufort Sea populations, with losses within the populations replaced within about 1 year. The combined effect of noise and disturbance, habitat alterations, and oil spills is likely to be short-term, with populations recovering within about 1 year.

Conclusion. The effects from activities associated with Beaufort Sea oil and gas exploration and development are estimated to include the loss from an oil spill (0.11 % chance) of small numbers of pinnipeds (perhaps 300 ringed seals but probably fewer than 10-20 spotted and 30-50 bearded seals and small numbers [fewer than 100] walruses), polar bears (6-10 bears), and beluga and gray whales (fewer than 10), with populations recovering (recovery meaning the replacement of individuals killed as a consequence of exploration and development) within about 1 year.

Effectiveness of Mitigating Measures. Stipulation 1 - Protection of Biological Resources primarily concerns protection of benthic habitats that may be buried or covered by drill-platform installation. The amount of benthic habitats (the probability is less than 1 square kilometer [0.62 square mile]) is not expected to be of consequence to marine mammal populations; thus, this stipulation is not expected to provide much protection to pinnipeds, polar bears, and gray and beluga whales.

Stipulation 2 - Orientation Program and ITL 4 - Information on Bird and Marine Mammal Protection likely would reduce potential noise and disturbance effects of air and vessel traffic on pinnipeds, polar bears, and gray and beluga whales. The Orientation Program is expected to inform oil-company workers and company contractors of the sensitivity of seals, polar bears, walruses, and gray and beluga whales to noise and disturbance from air and vessel traffic and to make the workers (and aircraft pilots) aware of the ITL and the recommended measures to be taken to avoid disturbing seal and walrus haulout areas.

Other standard stipulations are not expected to provide any additional protection for nonendangered marine mammals or to reduce potential adverse effects.

This analysis assumes that the oil industry and its contractors would comply with the ITL clause on Bird and Marine Mammal Protection and avoid flying within 1.6 kilometers (1 mile) of seal- and walrus-haulout sites and other known marine mammal-concentration areas, when weather conditions permitted them to avoid these areas. This compliance is expected to prevent excessive or frequent disturbance of seals, walruses, polar bears, and gray and beluga whales. However, some unavoidable disturbance of hauled out and feeding seals, beluga whales, and a few polar bears is expected to occur when (1) weather conditions prevent aircraft from flying at or above the recommended 545-meter (1,500-foot) altitude or within 1.6 kilometers (1 mile) or more from concentrations; (2) aircraft may fly low over concentrations of seals, walruses, polar bears, and gray or beluga whales during takeoffs and landings; and (3) boats may disturb some seals, polar bears, or beluga whales near ice floes in leads. These effects are expected to be short term and local and not to affect pinnipeds, polar bears, and gray or beluga whale populations.

The ITL 9 - Polar Bear Interaction likely would reduced the chances of oil workers-polar bear interactions by informing the lessees that oil workers and their contractors must avoid attracting polar bears to camp facilities and avoid encounters with polar bears that could lead to injury or death of the workers and polar bears. Existing guidelines on oil and gas operations in polar bears habitat have been effective in reducing lethal encounters between polar bears and oil workers. Only three lethal takes of polar bears were related to industrial activities on the North Slope over the past 20 years (Gorbics, Garlich-Miller, and Schliebe, 1998).

The ITL 11 - Information on Sensitive Areas to be Considered in the Oil-Spill-Contingency Plans may provide some protection, at least in theory, for nonendangered marine mammal sensitive habitats that are listed in the ITL (such as the lead system off Point Barrow). The lessees are informed that these areas should be protected in the event of an oil spill. However, it is unlikely that oil-spill-protection and -cleanup measures would prevent a large spill from contacting these marine mammal habitats, if wind and ocean currents were driving the spill into these areas.

If these mitigating measures are adopted for any of the Sales, the effects on pinnipeds, polar bears, and gray and beluga whales are expected to be about the same as with the measures enforced. This is because the measures that provide protection for marine mammals, primarily the ITL on Bird and Marine Mammal Protection, are still likely to be complied with by the lessees because of the Marine Mammal Protection Act. This act requires lessees to have a permit to conduct activities that may harass or take marine mammals to limit and avoid excessive harassment or taking of nonendangered marine mammals.

IV.C.7.b. Effects or Alternatives and Sales

IV.C.7.b(1) Effects of Alternative I for Sale 186

The effects of Alternative I for Sale 186 oil exploration and development on ringed, spotted, and bearded seals; polar bears; walruses; and beluga and gray whales are expected to be the same as described in the previous discussion in this section. They include local displacement within about 1-2 kilometers (0.62-1.2 miles) along the offshore pipelines and platform sites during installation, with this local effect persisting during construction activities. Brief disturbances (a few minutes to a few days) of groups of seals and walruses, pods of whales, and individual polar bears or sow and cubs could occur along the pipeline corridor during periods of high ice-road and air traffic, but these disturbances are not expected to affect marine mammal movements and distribution. If an oil spill occurred under Alternative I for Sale 186, it is expected to result in the loss of no more than a small number of seals, walruses, and polar bears and fewer beluga and gray whales, with recovery expected within about 1 year.

Seventy percent of the leasing activity and two production projects are expected to occur in the Near Zone, which includes the nearshore area from about the eastside of the Colville River Delta east to about Camden Bay (Map 4). One development project and 20% of the leasing activity are expected to occur in the Midrange Zone, which extends from about offshore of Cape Halkett east to about Barter Island. Only 10% of leasing activity and no projects or industrial activity is expected to occur in the Far Zone that extends west of Cape Halkett west to near Barrow and from near Barter Island east to the Canadian border (Map 4).

Conclusion: The effects from activities associated with Sale 186 exploration and development are estimated to include the loss of small numbers of pinnipeds, polar bears, and beluga and gray whales (perhaps 100-200 ringed seals, probably fewer than 10-20 spotted and 30-50 bearded seals, fewer than 100 walruses, perhaps 6-10 bears, and fewer than 10 beluga and gray whales), with populations recovering within about 1 year.

IV.C.7.b(2) Effects of Alternative I for Sales 195 and 202

The effects of Sales 195 and 202 oil exploration and development on pinnipeds; polar bears; beluga, and gray whales likely would be the same as described under Alternative I for Sale 186, because the amount of oil and the activities associated with these sales would have essentially the same effects on marine mammals as those identified for Alternative I for Sale 186.

Conclusion: The effects from activities associated with Alternative I for Sales 195 and 202 exploration and development are estimated to include the loss of small numbers of pinnipeds, polar bears, and beluga and gray whales (perhaps 100-200 ringed seals, probably fewer than 10-20 spotted and 30-50 bearded seals, fewer than 100 walruses, perhaps 6-10 bears, and fewer than 10 beluga and gray whales), with populations recovering within about 1 year.

IV.C.7.b(3) Effects of Alternatives III through VI for Sales 186 and 195

The effects of Beaufort Sea oil and gas exploration and development for these alternatives under these sales on pinnipeds, polar bears, and beluga and gray whales likely would be about the same as described under Alternative I for Sales 186 and 195, because the amount of oil and the activities associated with these alternatives and sales would have essentially the same effects on marine mammals as those identified for Alternative I for Sale 186.

Conclusion: The effects from activities associated with Alternatives III through VI for Sales 186 and 195 exploration and development are estimated to include the loss of small numbers of pinnipeds, polar bears, and beluga and gray whales (perhaps 100-200 ringed seals, probably fewer than 10-20 spotted and 30-50 bearded seals, fewer than 100 walruses, perhaps 6-10 bears, and fewer than 10 beluga and gray whales), with populations recovering within about 1 year.

IV.C.7.b(4) Effects of Alternatives III and V for Sale 202

The effects of Beaufort Sea oil and gas exploration and development under these alternatives for this sale on pinnipeds, polar bears, and beluga and gray whales likely would be about the same as described under Alternative I for Sale 202, because the amount of oil and the activities associated with these alternatives would have essentially the same effects on marine mammals as those identified for Alternative I for Sale 202.

Conclusion: The effects from activities associated with Alternatives IV, V, and VI for Sale 202 exploration and development are estimated to include the loss of small numbers of pinnipeds, polar bears, and beluga and gray whales (perhaps 100-200 ringed seals, probably fewer than 10-20 spotted and 30-50 bearded seals, fewer than 100 walruses, perhaps 6-10 bears, and fewer than 10 beluga and gray whales), with populations recovering within about 1 year.

IV.C.7.b(5) Effects of Alternatives IV and VI for Sale 202

These alternatives potentially could reduce noise and disturbance, habitat alteration, and oil-spill effects on pinnipeds, polar bears, and gray and beluga whales from in the following areas.

Under Alternative VI for Sale 202, effects could be reduced from about Barter Island east to Demarcation Bay. Potential conditional risks of oil contact to pinniped, polar bear, and beluga whale offshore habitats from about Barter Island east to Herschel Island (ERA's 36-37 sea/ice segments, assuming contact occurs within 30 days during the summer) would be reduced somewhat, if oil exploration and development were deferred under this alternative (Table A.2-21, LA 18). However, potential oil-spill risks to habitats west of the Beaufort Lagoon area (Table A.2-21, ERA's 29-35 Ice/Sea Segments 1-6) would be the same as described under general effects.

However potential oil-spill effects and noise and disturbance, and habitat effects on pinnipeds, polar bears, and gray and beluga whales east of Alternative III for Sale 202 and west of Alternative VI for Sale 202 would be the same as described under Alternative I for Sale 202.

Conclusion: The overall exploration and development effects of Alternatives IV and VI for Sale 202 on pinnipeds, polar bears, and beluga and gray whales likely would be about the same as described under Alternative I for Sale 202 because the amount of oil and the activities associated with these alternatives would have essentially the same effects on marine mammals as those identified.

IV.C.8. Terrestrial Mammals

Among the terrestrial-mammal populations that could be affected by oil exploration and development in the Beaufort Sea Planning Area are: caribou of the Central Arctic, Western Arctic, Teshekpuk Lake, and Porcupine Caribou herds; muskoxen; grizzly bears; and arctic foxes occurring along the coast adjacent to or near the planning area. The primary potential effects of OCS exploration and development activities on terrestrial mammals would come from ice-road and air-support traffic (disturbance) along pipeline corridors and near other onshore-support facilities and habitat alteration associated with gravel extraction (mining) to support the construction of offshore gravel islands and gravel pads for onshore facilities. Secondary effects could come from potential oil spills contacting coastal areas used by caribou for insect relief and scavenging by grizzly bears and arctic foxes.

IV.C.8.a. Effects Common to All Alternatives

The following effects are caribou, muskoxen, grizzly bears, and arctic foxes would occur the same for all alternatives and would result from routine operations or from unplanned unlikely large oil spills.

IV.C.8.a(1) Effects of Routine Operations for Exploration

The effects of exploration would occur primarily from routine operations. The unlikely effects associated with a very unlikely oil spill are discussed in Section IV.I.2.h.

IV.C.8.a(1)(a) Effects of Disturbances

Disturbance of caribou associated with exploration activities would come primarily from helicopter traffic. Aircraft traffic (about 140-155 helicopter round trips per year over a 2- to 4-year exploration period and 140 in the Far Zone to 155 in the Near and Midrange zones) centered primarily out of Deadhorse-Prudhoe Bay, traveling to and from the 1-2 exploration platforms/year and to and from one or two exploration platforms, is assumed to be a source of primary disturbance (see Section IV.A.1 and Table IV.A-4). Caribou have been shown to exhibit panic or violent flight reactions to aircraft flying at elevations of 60 meters (162 feet) or less and exhibit strong escape responses (animals trotting or running from aircraft) to aircraft flying at 150-300 meters (500-1,000 feet) (Calef, DeBock, and Lortie, 1976). These documented reactions of caribou were from aircraft that circled and repeatedly flew over caribou groups. Some of the aircraft traffic associated with exploration is likely to pass overhead of caribou once during any flight to or from the platforms; and the disturbance reactions of caribou are expected to be brief, lasting for a few minutes to no more than 1 hour and have no effect on caribou herd distribution and abundance. Muskoxen cows and calves appear to be more sensitive (responsive) to helicopter traffic than males and groups without calves, and muskoxen in general are more sensitive to overflights by helicopter than by fixed-wing aircraft (Miller and Gunn, 1979; Reynolds, 1986). A cow disturbed during the calving season may abandon her calf, if the calf is a day or two old (Lent, 1970). However, muskoxen appear to get used to helicopter flights above 500 feet (180 meters), at least for a time (Miller and Gunn, 1980). Groups of muskoxen responded less to fixed-wing flying over them during the summer, rutting season, and fall than during winter and calving periods (Miller and Gunn, 1980; Reynolds, 1986).

IV.C.8.a(1)(b) Effects of Habitat Alteration

No significant habitat alteration is expected to occur during exploration, because it is assumed that existing onshore-support facilities at Prudhoe Bay or other facilities will be used. The only habitat alteration that might occur would be gravel extraction from onshore-mining sites used in construction of an artificial gravel island. Such gravel is likely to come from existing quarries and would represent a very small (a few acres or hectares) loss of tundra habitat.

Summary. Exploration is expected to have very brief (few minutes to less than 1 hour) disturbance effects on caribou, muskoxen, grizzly bears, and arctic foxes with recovery occurring within 1 day or less for any disturbance event and have no effect on their populations.

IV.C.8.a(2) Effects of Development and Production

IV.C.8.a(2)(a) Effects from Routine Operations

The effects of routine operations are expected to occur if the proposed leasing occurs and results in exploration, development, and production activities. Routine operations that may affect terrestrial mammals include disturbances from transportation, pipelines, gravel mining, and small spills.

IV.C.8.a(2)(a)1) General Effects of Disturbance to Caribou

Caribou can be disturbed briefly by low-flying aircraft, fast-moving ground vehicles associated with onshore pipelines, and the construction of other facilities (Calef, DeBock, and Lortie, 1976; Horejsi, 1981). The response of caribou to potential disturbance is highly variable, from no reaction to violent escape reactions, depending on their distance from human activity; speed of approaching disturbance source; frequency of disturbance; sex, age, and physiological condition of the animals; size of the caribou group; and season, terrain, and weather. Cow and calf groups appear to be the most sensitive to vehicle traffic, especially during the early summer months immediately after calving, and bulls appear to be least sensitive during that season.

Tolerance to aircraft, ground-vehicle traffic, and other human activities has been reported in several studies of hoofed-mammal populations in North America including caribou (Davis, Valkenburg, and Reynolds, 1980; Valkenburg and Davis, 1985; Johnson and Todd, 1977). The variability and unpredictability of the arctic environment (snow conditions, late spring or early winter, etc.) dictate that caribou have the ability to adapt their behavior (such as change the time and route of migration) to some environmental changes. Consequently, repeated exposure to human activities such as oil exploration and development over several hundred square kilometers of summer range has led to some degree of tolerance by most caribou of the Central Arctic Herd. Some groups of caribou that overwinter in the vicinity of Prudhoe Bay and that have been continually exposed to disturbance stimuli apparently have become accustomed to human activities. However, most of the North Slope caribou herds that overwinter south of the Brooks Range are less tolerant to human activities, to which they are seasonally or intermittently exposed, than some caribou that overwinter on the arctic coast.

Some displacement of the Central Arctic Herd from a small portion of the calving range near the Prudhoe Bay and Milne Point facilities has occurred (Cameron, Whitten, and Smith, 1981, 1983; Cameron et al., 1992). This displacement of some caribou cows and calves has occurred within about 1-2 kilometers (0.62-1.2 miles) of some oil facilities (Dau and Cameron, 1986). The use of specific calving sites within the broad calving area varies from year to year; and the amount of displacement may be of secondary importance due to the low density of caribou on the calving range and the abundance of the Central Arctic Herd's calving habitat.

IV.C.8.a(2)(a)2) General Effects of Disturbance to Muskoxen

Muskoxen cows and calves appear to be more sensitive (responsive) to helicopter traffic than males and groups without calves, and muskoxen in general are more sensitive to overflights by helicopter than by fixed-wing aircraft (Miller and Gunn, 1979; Reynolds, 1986). A cow disturbed during the calving season may abandon her calf, if the calf is a day or two old (Lent, 1970). However, muskoxen appear to get used to helicopter flights above 500 feet (180 meters), at least for a time (Miller and Gunn, 1980). Groups of muskoxen responded less to fixed-wing flying over them during the summer, rutting season, and fall than during winter and calving periods (Miller and Gunn, 1980; Reynolds, 1986).

Studies on the effects of oil and gas exploration on muskoxen in Alaska and Canada have focused on disturbances associated with winter seismic operations. Some muskoxen reacted to seismic activities at distances up to 2.48 miles(4 kilometers) from the operations; however, reactions by muskoxen were highly variable among individuals, with some individuals not reacting at very close distances (0.12 miles [0.2 kilometers]) (Reynolds and LaPlant, 1985). Responses varied from no response to becoming alert, forming defense formations, or running away (Winters and Shideler, 1990). The movements of muskoxen away from the seismic operations did not exceed 3.1 miles (5 kilometers) and had no apparent effect on muskoxen distribution (Reynolds and LaPlant, 1986). Helicopter support traffic seemed to have a cumulative effect on muskoxen responses to seismic activities (Jingfors and Lassen, 1984). Muskoxen reacted to helicopters flown at 325 and 1,300 feet (100 and 400 meters) with response durations lasting from 2-12 minutes (Miller and Gunn, 1984). Muskox cows and calves appear to be more sensitive (responsive) to helicopter traffic than other age/sex classes, and muskoxen in general are more sensitive to overflights by helicopter than by fixed-wing aircraft (Miller and Gunn, 1979; Reynolds, 1986). Disturbances during the calving season may result in abandonment of the calf, if it occurs within the first or second day of life (Lent, 1970). Muskoxen appear to habituate to helicopter flights above about 500 feet (180 meters), at least on a short-term basis (Miller and Gunn, 1980).

In general, muskoxen responses to seismic activities in the planning area are expected to be a gradual and temporary avoidance of the local area, with reoccupation of the area after exploration activities are complete (Urquhart, 1973; Jingfors and Lassen, 1984).

Potential effects of oil-development activities include direct habitat loss from gravel mining in river floodplains and at oil field facilities, and indirect habitat loss through reduced access caused by physical or behavioral barriers created by roads, pipelines, and other facilities (Clough et al., 1987, as cited by Winters and Shideler, 1990; Garner and Reynolds, 1986). Muskoxen may be more exposed to oil exploration and development than caribou, because they tend to remain year-round in the same habitat area (Jingfors, 1982); therefore, muskoxen may be more likely to habituate because of this year-round exposure. Muskoxen have been exposed to the Trans-Alaska Pipeline System and the Dalton Highway with the expansion of their range west from the Arctic National Wildlife Refuge and the Kavik River.

IV.C.8.a(2)(a)3) General Effects of Disturbance to Grizzly Bears

Major sources of noise and disturbance include air and ground vehicle traffic and human presence associated with onshore operations, such as construction of ice roads, installation of onshore pipelines, and gravel mining. These activities may disturb grizzly bears occurring within a few miles of the activities. However, most onshore construction activities such as gravel mining, ice-road construction and ice-road traffic is assumed to occur during the winter months when grizzly bears are denning. In the case of denning bears, industrial activities and human presence pose potentially serious disturbances. In one study, seismic activities within 1.15 miles (1.8 kilometers) of a grizzly bear den caused changes in heart rate and movement of the female bear and cubs (Reynolds, Reynolds, and Follman, 1986). The investigators suggest that seismic-testing activities within about 600 feet of the den may cause abandonment of the den. Human scent and other noises also may disturb the bears.

Initially, when grizzly bears first encounter humans on foot, their response is to flee; responses to ground-based human activities are stronger than responses to aircraft, especially when encounters occur in open areas such as the Arctic Slope (McLellan and Shackleton, 1989). The increase in human presence and encounters with grizzly bears associated with recreation and tourism usually is temporary in nature. However, the establishment of permanent settlements (oil fields, mines, etc.) usually leads to human-bear encounters on a regular basis and to conflict, particularly when bears learn to associate humans with food (Schallenberger, 1980; Harding and Nagy, 1980; Miller and Chihuly, 1987; McLellan, 1990). Grizzly bears initially will avoid human settlements because of the noise and disturbance (Harding and Nagy, 1980), but if the area includes an important food source (such as a fish stream), some bears are likely to habituate to the noise and human presence, leading to an increase in encounters. People often will not accept the risk of bear attacks, and these encounters too often lead to the loss of bears (Archibald, Ellis, and Hamilton, 1987). However, individual bears, especially females with cubs, vary in the degree of habituation-tolerance to human presence, and some will continue to avoid areas when humans are present (Olson and Gilbert, 1994).

The attraction of grizzly bears to garbage and/or food odors at field camps and other facilities has led to encounters in which the need to protect workers results in the loss of bears (Schallenberger, 1980). Once bears become conditioned to the availability of human sources of food, measures to reduce this availability by improved garbage handling are not always effective (McCarthy and Seavoy, 1994). The bears will make an extra effort to get to the food sources that they are conditioned to having. Cubs of female bears conditioned to anthropogenic food source and habituated to human presence have a higher survival rates as cubs but have a high mortality rate after they are weaned (Shideler and Hechtel 2000). These young-habituated bears are more vulnerable to Dalton Highway hunters and to being killed near settlements and camps in human-bear encounters.

However, grizzly bears that occur along the coast of the planning area are not likely to encounter construction workers and most onshore development activities, because they will take place during winter when the bears are denning, and because the camps will be located on the production island offshore. Grizzly bears use earthen dens along riverbanks during winter months where gravel extraction for the construction of gravel pads and gravel islands supporting offshore oil development may occur. This mining activity could disturb and displace a few bears from den sites. Advising oil workers to consult the MMS publication *Guidelines for Oil and Gas Operations on Polar Bear Habitats* to minimize interactions with polar bears also would be applicable to encounters with grizzly bears. Implementing these guidelines would reduce the chances of adverse grizzly bear-human interactions that may lead to the injury or loss of people and bears.

IV.C.8.a(2)(a)4) General Effects of Disturbance to Arctic Fox

Oil and gas exploration and development activities can affect the arctic fox by increasing the availability of food and shelter. Seismic camps and oil-field facilities provide additional food sources for foxes at dumpster sites near the galley and dining halls and at dumpsites (Eberhardt et al., 1982; Rodrigues, Pollard, and Skoog, 1994). Crawlspaces under housing, culverts, and pipes provide foxes with shelter for resting and, in some cases, artificial dens (Eberhardt et al., 1982; Burgess and Banyas, 1993). At least localized seismic and oil-development activities do not appear to have any dramatic, deleterious effect on the fox population (Eberhardt et al., 1982). A study of den sites and fox productivity in the area of Prudhoe Bay indicates that adult fox densities and pup production are higher in the oil fields than in surrounding undeveloped areas (Burgess et al., 1993). An increase in the fox population associated with oil development may adversely affect some fox-prey species (such as ground-nesting birds) in the development area and over a region larger than the oil field itself (Burgess et al., 1993).

IV.C.8.a(2)(a)5) Effects of Aircraft Traffic

Some of the helicopter traffic associated with development 300-600 round-trip flights/month during construction, 28-56 during development, and 12-28 during production) is likely to pass overhead of caribou once during any flight to or from the eight production platforms under the assumed three sales in the Beaufort Sea Planning Area. The disturbance reactions of caribou are expected to be brief, lasting for a few minutes to no more than 1 hour and have no effect on caribou and muskoxen distribution and abundance.

IV.C.8.a(2)(a)6) Effects of Pipelines

Some Natives of the North Slope believe that caribou migration movements have changed since the construction of the Trans-Alaska Pipeline (Jonas Ningeok, as cited in Kruse et al., 1983). Recent studies (Roby, 1978; Cameron, Whitten, and Smith, 1981, 1983; Cameron et al., 1992; Pollard and Ballard, 1993) indicate significant seasonal avoidance of habitat near (within 1-2 kilometers [0.62-1.2 miles]) some existing Prudhoe Bay area facilities by cows and calves during calving and early postcalving periods (May through June). Therefore, disturbance from vehicle traffic and human presence associated with present levels of oil development in the Prudhoe Bay area apparently has affected local distribution on a small percentage (an estimated 5%) of the caribou's summer range. However, caribou abundance and overall distribution have not been affected, and the Central Arctic Herd has greatly increased since oil development began, although this increase in caribou numbers is not to be inferred as having been caused by oil development. Caribou successfully cross under pipelines that are elevated a minimum of 5 feet above the tundra, a requirement for onshore pipelines on the North Slope. Pipelines without adjacent roads and vehicle traffic are not likely to affect caribou movements. Some Natives from Kaktovik have noticed that caribou overwintering on the North Slope have become scarce since development of the oil fields (Herman Rexford, 1982).

Ice-road traffic (such as 3-6 vehicles/hour during the assumed 90-day use of ice roads) could have the greatest manmade influence on behavior and movement while caribou are crossing the Prudhoe Bay and Kuparuk oil fields and pipeline corridors (Murphy and Curatolo, 1984; Lawhead and Flint, 1993).

However, this traffic would occur only during winter months along ice roads (about 90 days), when most caribou are on their winter range south of the North Slope.

IV.C.8.a(2)(a)7) Effects of Habitat Alteration

The construction of pipelines and other onshore facilities on the North Slope necessitates the use of very large quantities (several million tons) of gravel. With the construction of roads and gravel pads for facility-building sites, small areas of tundra vegetation are excavated at the gravel-quarry sites. However, the several square kilometers of caribou and muskoxen tundra-grazing habitat destroyed by onshore development represent a very small percentage of the range habitat available to the caribou herd and muskoxen populations. The construction of roads and gravel pads also provides the caribou with additional insect-relief habitat on the roads and gravel pads, particularly when there is little or no road traffic present.

Among the terrestrial-mammal populations that could be affected by onshore pipeline construction are caribou of the Teshekpuk Lake and Central Arctic herds. Caribou of the Western Arctic Herd are not expected to be greatly affected, because their calving range is located far to the west of the planning area (Figure III.B-4). Some Western Arctic Herd caribou temporarily may be exposed to helicopter traffic and other activities associated with pipeline construction, but such exposure is not expected to have any effects on the population. Arctic foxes may be locally affected by this activity. Small rodents (such as lemmings and voles) and their predators (such as short-tailed weasels) could be affected locally along the pipelines, landfall gravel pads, and other facilities. However, these losses are expected to be insignificant to populations on the Arctic Slope of Alaska.

IV.C.8.a(2)(a)8) Effects of Gravel Mining on Caribou and Muskoxen

Gravel mining would alter a small area of river habitat along rivers but would not disturb many terrestrial mammals. Most caribou migrate south to the Brook s Range during the winter months when gravel will be mined, but small bands may be present.

Muskoxen use riparian (river) habitats on the North Slope, where gravel-mining sites may be located and the gravel used to construct pipeline landfall gravel pads and other gravel pad facilities associated with offshore oil development.

IV.C.8.a(2)(a)9) Effects of Habitat Alteration on Arctic Foxes

Arctic foxes could benefit from development in the Beaufort Sea area, because they would find shelter under buildings and potential food sources (temporary refuse storage) that would be on the production island. Camps and oil-field facilities in the Prudhoe Bay area provide food sources for foxes at dumpster sites near galleys and dining halls and at dumpsites (Eberhardt et al., 1982; Rodrigues, Pollard, and Skoog, 1994). Crawlspaces under housing, culverts, and pipes provide foxes with shelter for resting and, in some cases, artificial dens (Eberhardt et al., 1982; Burgess and Banyas, 1993). Oil development has not harmed the fox population (Eberhardt et al., 1982). Arctic fox numbers and productivity are higher in the Prudhoe Bay area compared to adjacent undeveloped areas (Burgess et al., 1993). An increase in the fox population could adversely affect ground-nesting birds in the Prudhoe Bay area and in nearby undeveloped areas (Burgess et al., 1993).

IV.C.8.a(2)(a)10) Effects of Site-Specific Onshore Development

Assuming oil development takes place in the Beaufort Sea, the following potential oil-transportation (pipeline) projects and facility-construction projects could take place and potentially affect caribou, muskoxen, grizzly bears, and arctic foxes. Development of projects would include the landfalls at either the existing facilities located at Oliktok Point, Northstar landfall, West Dock, or the Badami Field for development in the Near Zone (Map 4); additional landfalls at either Bullen Point and Point Thomson for development in the Midrange Zone; and landfalls for the potential development in the Far Zone at either Smith Bay for a western Beaufort Sea discovery or Point Thomson for an eastern Beaufort Sea discovery (Map 4). The pipeline corridors are assumed not to include interconnecting roads to the Prudhoe Bay complex. The Alpine/Badami oil-transportation model would be incorporated in the proposed development.

IV.C.8.a(2)(a)10)a) Oil Transportation East of Point Thomson

Oil transportation from assumed platforms located in Camden Bay and connecting with the leases from Beaufort Sea sales in this area is assumed to be by offshore pipeline connecting to an onshore pipeline with a landfall at Point Thomson. The onshore pipeline (12 miles long) from Point Thomson (or Flaxman Island) to the Badami facilities would increase air traffic by perhaps 155-600 flights per year during construction, which could temporarily disturb some caribou along the pipeline route from during construction activities. Disturbance and habitat effects on the Central Arctic and Porcupine caribou herds are expected to be short term, (probably a few minutes to less than a few days); caribou eventually would cross the pipeline corridor. Additionally, disturbance reactions would diminish after construction is complete, and air-traffic levels are likely to decrease to 12-28 per year at the most. The abundance and overall distribution of the Central Arctic and Porcupine caribou herds are not likely to be affected by the construction and operation of oil-transportation facilities east of Prudhoe Bay that are assumed to be associated with Alternative I for Sales 186, 195, and 202.

IV.C.8.a(2)(a)10)b) Oil Transportation West of Harrison Bay

It is assumed that oil would be transported from offshore platforms located west of Prudhoe Bay, with the landfall located on the coast of Smith Bay. Construction and support activities associated with this pipeline-landfall and 5-mile long pipeline to the Alpine development facilities could temporarily disturb some caribou (of the Teshekpuk Lake and Western Arctic herds), muskoxen, grizzly bears, and arctic foxes, particularly when there are high levels of air and ice-road along the pipeline corridor during construction.

IV.C.8.a(2)(a)11) Effects of Small Oil Spills

Over the production life of the Beaufort multiple sales, 82 small crude oil spills (3 barrels) and 157-202 small refined oil spill (average of 0.7 barrels) are estimated to occur (Tables A-6b and A-6e). These onshore spills likely would occur on gravel pads near the tie-in locations and should have only a minimal effect on terrestrial mammals. These minor spills could have an additive effect on caribou, muskoxen, grizzly bears, and arctic foxes perhaps increasing contamination of terrestrial habitats at facility sites and along pipelines by perhaps 1-2%. Some tundra vegetation in the pipeline corridor would become contaminated from these spills. However, caribou and muskoxen probably would not ingest oiled vegetation, because they are selective grazers and are particular about the plants they consume (Kuropat and Bryant, 1980). If a pipeline spill occurred, it is likely that control and cleanup operations (ground vehicles, air traffic, and personnel) at the spill site likely would frighten caribou, muskoxen, grizzly bears, and arctic foxes away from the spill and prevent the possibility of caribou and muskoxen grazing on the oiled vegetation. Thus, onshore oil spills associated with Alternative I for Sales 186, 195, and 202 are not likely to directly affect caribou or muskoxen through ingestion of oiled vegetation.

IV.C.8.a(2)(b) Effects of a Large Oil Spill

IV.C.8.a(2)(b)1) General Effects of a Large Oil Spill

Caribou sometimes frequent barrier islands and shallow coastal waters during periods of heavy insect harassment and may possibly become oiled or ingest contaminated vegetation. During late winter-spring, caribou move out on to the ice and lick sea ice for the salt and, thus, may be exposed to oil if a spill contaminates the ice (Roosman Petook of Barrow, 1983). Caribou that become oiled are not likely to suffer the loss of thermoinsulation through fur contamination, although toxic hydrocarbons could be absorbed through the skin and also could be inhaled.

Oiled caribou hair would be shed during the summer before the caribou grow their winter fur. Toxicity studies of crude-oil ingestion in cattle (Rowe, Dollahite, and Camp, 1973) indicate that anorexia (significant weight loss) and aspiration pneumonia leading to death are possible adverse effects of oil ingestion in caribou. However, caribou frequent coastal areas to avoid insects and, thus, are not likely to be grazing on coastal or tidal plants that may become contaminated. In the event of an onshore oil spill that contaminated tundra habitat, caribou probably would not ingest oiled vegetation, because they are selective grazers that are particular about the plants they consume. However, caribou that become oiled by contact with a spill in coastal waters could die from toxic hydrocarbon inhalation and absorption through the skin.

Muskoxen may become oiled or may ingest contaminated vegetation. Muskoxen that become oiled are not likely to suffer from a loss of thermoinsulation during the summer, although toxic hydrocarbons could be absorbed through the skin or inhaled. However, the oiling of young calves significantly could reduce thermoinsulation, leading to their death. Oiled hair would be shed during the summer before the winter fur is grown. Toxicity studies of crude-oil ingestion in cattle (Rowe, Dollahite, and Camp, 1973) indicate that anorexia (significant weight loss) and aspiration pneumonia leading to death are possible adverse effects. Muskoxen that become oiled by contact with a spill in lakes, ponds, rivers, or coastal waters could die from toxic hydrocarbon inhalation and absorption through the skin. The number affected is expected to be fewer than 10 individuals, based on their scattered distribution on the North Slope.

Grizzly bears depend on coastal streams, beaches, mudflats, and river mouths during the summer and fall for catching fish and finding carrion. If an oil spill contaminates beaches and tidal flats along the Beaufort Sea coast, some grizzly bears, and some arctic foxes, are likely to ingest contaminated food, such as oiled birds, seals, or other carrion. Such ingestion could result in the loss of at least a few bears and a few foxes through kidney failure and other complications (Oritsland et al., 1981; Derocher and Stirling, 1991). The number affected is expected to be fewer than 10 individuals, based on their scattered distribution on the North Slope.

IV.C.8.a(2)(b)2) Site-Specific Effects of a Large Oil Spill

Unless otherwise specified, the probabilities of oil-spill contact referred to in this section assume the occurrence of exploration and development activities to the extent estimated for Alternative I for Sales 186, 195, and 202 in Section IV.A.1.a and associated spill rates (Section IV.A.2). The mean number of one or more oil spills occurring during exploration and development is 0.11. The most likely number of spills greater than or equal to 1,000 barrels is zero. Attention is devoted to a platform oil spill of 1,500 barrels or a pipeline spill of 4,600 barrels and to spill contacts that occur within 180 days during the summer season.

In the unlikely event that a 1,500-barrel or 4,600-barrel platform or pipeline oil spill occurred during the open-water season or during winter and melted out of the ice during spring, some caribou of the Central Arctic, Teshekpuk Lake, Western Arctic, and Porcupine herds that frequent coastal habitats from Demarcation Bay (Land Segment 52) west to Point Barrow (Land Segment 25) could be directly exposed to and contaminated by the spill along the beaches and in shallow waters during periods of insect-pest-escape activities (Figure III.B-4). An estimated 29-49 kilometers of coastline could be oiled by a 1,500-barrel or 4,600-barrel spill. However, even in a severe situation, a comparatively small number of animals (perhaps a few hundred) are likely to be directly exposed to the oil spill and die as a result of toxic hydrocarbon inhalation and absorption. This loss probably would be small for any of the caribou herds, with these losses replaced within about 1 year. The numbers of muskoxen, grizzly bears, and arctic foxes affected likely would be fewer than 10 individuals/species, based on their scattered distribution on the North Slope.

Coastline habitats from Dease Inlet, Cape Simpson east to Atigaru Point-Kogru River (Land Segments 26, 28-33, and 47) and coastline habitats in the Kaktovik area (Land Segment 74) have the highest chance of contact, greater than 15% up to 21%, from either LA1-LA18 or P1-P13, assuming spills occur during the summer season within 30 days (Table A.2-27). Assuming a spill occurs within LA6 north of the Teshekpuk Lake Special Use Area, there is up to a 45% chance that a spill would contact the shoreline of the special use area (Land Segments 29-33) within 30 days during the summer open-water season (Table A.2-87). Assuming a spill occurs within LA18 offshore of the Arctic National Wildlife Refuge, there is is up to a 49% chance that a spill would contact the shoreline (Land Segments 43-51) within 30 days during the summer open-water season (Table A.2-87). Some caribou from the Teshekpuk Lake, Western Arctic, Central Arctic, and Porcupine herds are more likely to contact oil in these areas. Caribou move into these areas to escape insects. However, even in a severe situation, perhaps 10 to a few hundred animals from one of these herds could get oil on their coats and die from toxic hydrocarbon inhalation and absorption.

Over the production life of the Beaufort Sea multiple sales, 82 small crude oil spills (3 barrels) and 157-202 small refined oil spills (average of 0.7 barrels) are estimated to occur (Tables A.1-6b and A.1-6e). These minor spills could have an additive effect on caribou, muskoxen, grizzly bears, and arctic foxes, increasing losses by perhaps a few animals and increasing coastal and tundra habitat contamination by perhaps about 1-2%.

IV.C.8.a(2)(b)3) Effects of Disturbance from Oil-Spill Cleanup

In the event of a large oil spill contacting and extensively oiling coastal habitats with herds or bands of caribou during the insect season, the presence of several thousand humans, hundreds of boats, and several aircraft operating in the area involved in cleanup activities is expected to cause displacement of some caribou in the oiled areas and contribute temporarily to seasonal stress on some caribou. This effect is expected to occur during cleanup operations (perhaps 1 or 2 seasons) but is not expected to significantly affect the caribou herd movements or the foraging activities of the populations.

Cleaning up a large oil spill also would disturb some muskoxen, grizzly bears, and arctic foxes. The presence of several thousand humans, hundreds of boats, and several aircraft operating to clean up the area probably would displace some muskoxen, grizzly bears, and arctic foxes. An oil spill could result in the loss of small numbers of grizzly bears and arctic foxes through ingestion of contaminated prey or carrion. However, such losses likely would not affect their populations on the Arctic Slope.

Onshore oil spills on wet tundra kill the moss layers and aboveground parts of vascular plants, or they kill all macroflora at the spill sites (McKendrick and Mitchell, 1978). Thus, pipeline oil spills can destroy or alter the local grazing habitat along the pipeline corridor. Damage to oil-sensitive mosses may persist for several years, if the spill sites are not rehabilitated (for example, by applying phosphorus fertilizers to spill sites) (McKendrick and Mitchell, 1978). For the most part, the effect of onshore oil spills would be very local and would contaminate tundra in the immediate vicinity of the pipeline; these spills would not be expected to significantly contaminate or alter caribou and muskoxen range within the pipeline corridors.

Summary. Under development, the primary source of disturbance to caribou, muskoxen, grizzly bears, and arctic foxes is air and ice-road traffic (perhaps as much as 300-600 aircraft/vehicles/month during construction and 12-28 aircraft/vehicles/month during operation) that could be associated with onshore construction and transportation of oil from offshore leases. Disturbance of caribou, muskoxen, grizzly bears, and arctic foxes along the onshore pipelines to the Trans-Alaska Pipeline through existing facilities in the Prudhoe Bay and adjacent oil fields would be most intense during the construction period (perhaps 6 months), when ice-road traffic is highest, but would subside after construction is complete. Caribou and muskoxen are likely to successfully cross the pipeline corridor within a short period of time (a few minutes to a few hours) during breaks in the traffic flow, even during high traffic periods, with little or no restriction in movements.

Because oil transportation for development of Federal offshore leases east of the Canning River is expected to be located offshore of the Arctic National Wildlife Refuge caribou of the Porcupine Caribou Herd that calve on the Refuge are not likely to be affected by Alternative I for Sales 186, 195, and 202.

The mean number of one or more oil spills greater than or equal to 1,000 barrels occurring during exploration and development is 0.11. The most likely number of spills greater than or equal to 1,000 barrels is zero. A possible oil spill (1,500 or 4,600 barrels) could cause the loss of small numbers (perhaps 10 to a few hundred) of caribou. The numbers of muskoxen, grizzly bears, and arctic foxes affected are expected to be fewer than 10 individuals/species, based on their scattered distribution on the North Slope.

Coastline habitats from Dease Inlet, Cape Simpson east to Atigaru Point-Kogru River (Land Segments 26, 28-33, and 47), and coastline habitats in the Kaktovik area (Land Segment 47) have the highest chance of contact (greater than 15% up to 21%) from either LA1-LA18 or P1-P13, assuming spills occur during the summer season within 30 days (Table A-27). An estimated 29-49 kilometers of coastline could be oiled by the 1,500- or 4,600-barrel spill. Some caribou from the Teshekpuk Lake, Western Arctic, Central Arctic, and Porcupine Caribou herds could contact oil in these areas. Caribou move into these areas to escape insects. However, even in a severe situation, perhaps 10 to a few hundred animals from one of these herds could get oil on their coats and die from toxic hydrocarbon inhalation and absorption. This loss probably would be small for any of these caribou herds and would be replaced within about 1 year.

For the most part, the effect of onshore oil spills would be very local and would contaminate tundra in the immediate vicinity of the pipeline; these spills would not be expected to significantly contaminate or alter caribou and muskoxen range within the pipeline corridors.

Conclusion. The effects of Beaufort Sea oil exploration and development on caribou, muskoxen, grizzly bears, and arctic foxes likely would include local displacement within about 1-2 kilometers (0.62-1.2 miles) along the onshore pipelines, with this local effect persisting during construction activities. Brief disturbances (a few minutes to a few days) of groups of caribou and muskoxen could occur along the pipeline corridor during periods of high ice-road and air traffic, but these disturbances likely would not affect caribou, muskox, grizzly bear, and arctic fox movements and distribution. If an oil spill occurred in the Beaufort Sea, it likely would result in the loss of no more than a small number of caribou (perhaps 10 to a few hundred), probably fewer than 10 individual muskoxen, grizzly bears, and arctic foxes, with recovery expected within about 1 year.

Effectiveness of Mitigating Measures. The ITL 1 - Information on Bird and Mammal Protection is expected to indirectly reduce noise and disturbance effects of air and vessel traffic on caribou, muskoxen, grizzly bears, and arctic foxes occurring along the coast of the sale area. This measure recommends air- and vessel-traffic distances to avoid disturbance of birds and marine mammals that generally use many of the same coastal habitats as terrestrial mammals and is expected to prevent frequent disturbance of caribou from air traffic along the coast of the sale area. However, air traffic, on occasion, likely would disturb individuals or small numbers of caribou, muskoxen, grizzly bears, and arctic foxes. This effect is expected to be short term and local and is not expected to affect their populations.

IV.C.8.b. Effects Alternatives and Sales

IV.C.8.b(1) Effects Alternative I for Sale 186

The effects of Alternative I for Sale 186 on caribou, muskoxen, grizzly bears, and arctic foxes are expected to be the same as described under general effects. They include local displacement within about 1-2 kilometers (0.62-1.2 miles) along the onshore pipelines, with this local effect persisting during construction activities. Brief disturbances (a few minutes to a few days) of groups of caribou and muskoxen could occur along the pipeline corridor during periods of high ice-road and air traffic, but these disturbances are not expected to affect caribou, muskoxen, grizzly bear, and arctic fox movements and distribution. If an oil spill occurred under Alternative I for Sale 186, it likely would result in the loss of no more than a small number of caribou (perhaps 10 to a few hundred), fewer than 10 individual muskoxen, grizzly bears, and arctic foxes, with recovery expected within about 1 year.

Two production projects and 70% of the leasing activity are expected to occur in the Near Zone, which includes the nearshore area from about the eastside of the Colville River Delta east to about Camden Bay (Map 4). One development project and 20% of the leasing activity are expected to occur in the Midrange Zone, which extends from about offshore of Cape Halkett east to about Barter Island. Only 10% of leasing activity and no projects or industrial activity is expected to occur in the Far Zone, which extends west of Cape Halkett west to near Barrow and extends from near Barter Island east to the Canadian border (Map 4).

Conclusion: The effects of Alternative I for Sale 186 on caribou, muskoxen, grizzly bears, and arctic foxes are expected to include local displacement within about 1-2 kilometers (0.62-1.2 miles) along the onshore pipelines, with this local effect persisting during construction activities. Brief disturbances (a few minutes to a few days) of groups of caribou and muskoxen could occur along the pipeline corridor during periods of high ice-road and air traffic, but these disturbances are not expected to affect caribou, muskoxen, grizzly bear, and arctic fox movements and distribution. If an oil spill occurred in the Beaufort Sea, it likely would result in the loss of no more than a small number of caribou (perhaps 10 to a few hundred), fewer than 10 individual muskoxen, grizzly bears, and arctic foxes, with recovery expected within about 1 year.

IV.C.8.b(2) Effects of Alternative I for Sales 195 and Sale 202

The effects of oil exploration and development from Alternative I for Sales 195 and 202 on caribou, muskoxen, grizzly bears, and arctic foxes likely would be the same as described under Sale 186 because the level of activities and their effects on terrestrial mammals are essentially the same as those for Alternative I for Sale 186.

Conclusion: The effects of Alternative I for Sales 195 and 202 on caribou, muskoxen, grizzly bears, and arctic foxes are expected to include local displacement within about 1-2 kilometers (0.62-1.2 miles) along the onshore pipelines, with this local effect persisting during construction activities. Brief disturbances (a few minutes to a few days) of groups of caribou and muskoxen could occur along the pipeline corridor during periods of high ice-road and air traffic, but these disturbances are not expected to affect caribou, muskoxen, grizzly bear, and arctic fox movements and distribution. If an oil spill occurred in the Beaufort Sea, it likely would result in the loss of no more than a small number of caribou (perhaps 10 to a few hundred), fewer than 10 individual muskoxen, grizzly bears, and arctic foxes, with recovery expected within about 1 year.

IV.C.8.b(3) Effects of Alternatives III through VI for Sales 186 and 195

The effects of Beaufort Sea oil and gas exploration and development for these alternatives for Sale 186 and 195 on caribou, muskoxen, grizzly bears, and arctic foxes likely would be about the same as described under Alternative I for Sales 186 and 195, respectively, because the level of activities are essentially the same as those for Alternative I for Sale 186.

Conclusion: The effects of Alternatives III through VI for Sales 186 and 195 on caribou, muskoxen, grizzly bears, and arctic foxes are expected to include local displacement within about 1-2 kilometers (0.62-1.2 miles) along the onshore pipelines, with this local effect persisting during construction activities. Brief disturbances (a few minutes to a few days) of groups of caribou and muskoxen could occur along the pipeline corridor during periods of high ice-road and air traffic, but these disturbances are not expected to affect caribou, muskoxen, grizzly bear, and arctic fox movements and distribution. If an oil spill occurred in the Beaufort Sea, it likely would result in the loss of no more than a small number of caribou (perhaps 10 to a few hundred), fewer than 10 individual muskoxen, grizzly bears, and arctic foxes, with recovery expected within about 1 year.

IV.C.8.b(4) Effects of Alternatives III, IV and V for Sale 202

The effects of Alternatives III, IV, and V for Sale 202 on caribou, muskoxen, grizzly bears, and arctic foxes likely would be about the same as described under Alternative I for Sale 202, because the level of activities and their effects on terrestrial mammals are essentially the same.

Conclusion: The effects of Alternatives III, IV, and V for Sale 202 on caribou, muskoxen, grizzly bears, and arctic foxes are expected to include local displacement within about 1-2 kilometers (0.62-1.2 miles) along the onshore pipelines, with this local effect persisting during construction activities. Brief disturbances (a few minutes to a few days) of groups of caribou and muskoxen could occur along the pipeline corridor during periods of high ice-road and air traffic, but these disturbances are not expected to affect caribou, muskoxen, grizzly bear, and arctic fox movements and distribution. If an oil spill occurred in the Beaufort Sea, it likely would result in the loss of no more than a small number of caribou (perhaps 10 to a few hundred), fewer than 10 individual muskoxen, grizzly bears, and arctic foxes, with recovery expected within about 1 year.

IV.C.8.b(5) Effects of Alternative VI for Sale 202

This alternative for Sale 202 potentially could reduce noise and disturbance, habitat alteration, and oil-spill effects on caribou, muskoxen, grizzly bears, and arctic foxes in the following areas.

Under Alternative VI for Sale 202, noise and disturbance and habitat effects could be reduced from about Barter Island east to Demarcation Bay. The chance of contact to terrestrial mammal coastal habitats from about Beaufort Lagoon east to Herschel Island (Land Segments 49-55), within 30 days during summer), would be reduced (2-11%) if oil exploration and development were deferred under this alternative (Table A.2-27, LA18). However, the chance of contact to coastal habitats west of Beaufort Lagoon (Table A.2-27, Land Segments 25-48) would be about the same as described in Section IV.C.8.b.

Conclusion: The overall effects Alternative VI for Sale 202 on caribou, muskoxen, grizzly bears, and arctic foxes likely would be about the same as described under Alternative I for 202.

IV.C.9. Vegetation and Wetlands

IV.C.9.a. Effects Common to All Alternatives

IV.C.9.a(1) Effects of Routine Operations

IV.C.9.a(1)(a) Effects of Gravel Pads

We assume that gravel fill would cover less than 1 acre of tundra at the pads. Some nearby tundra vegetation would be partially covered by dust that blows off the gravel pads and smothers some of the original plants, resulting in a shift to weedy species, and cause thermokarsting, which develops into high-centered polygons with deep moats (Jorgenson, 1997, as cited by U.S. Army Corps of Engineers, 1999). For purposes of analysis, we assume the projects would include an onshore valve and helicopter pad at the shore crossing, pipeline tie ins, and gravel pads at pipeline booster stations, which may spread dust over a few acres. This local effect, however, would not be significant to the tundra ecosystem in the project areas or in the Beaufort Sea Planning Area.

A gravel pad can change the moisture in the nearby tundra, because the pad causes snow to drift and accumulate around it and blocks normal surface-water flow in the summer. This blockage thickens the active layer (soil that thaws during summer), which increases production of grasses and mosses in wet habitats or decreases production of shrubs and lichen in moist or dry habitats within about 160 feet of the pad (Woodward-Clyde Consultants, 1993). Thus, changes in water drainage and tundra moisture (wetness) have occurred near gravel pads.

From 1968-1983, flooding caused the greatest effect on vegetation. In the Prudhoe Bay oil field during the first 15 years of development (Walker et al., 1986, 1987), flooding resulted when roads and pads intercepted the natural flow of water and caused ponding. The onshore development would have to identify natural drainage patterns before construction and maintain them during and after construction. Even if such conditions were not required (under U.S. Army Corps of Engineers permits) or completely successful, flooding would affect no more land than that affected by dust and snow drifting, as described earlier. The change in vegetation from flooding could result in more aquatic grasses and sedges versus dwarf shrubs. However, because the onshore pipeline gravel pads and landfall-site development will cover no more than a few acres, they are likely to have very little effect on nearby tundra. We assume that standard dust-abatement practices, as currently used in North Slope oil fields, would be implemented in the planning area. These measures would minimize the amount of dusting of tundra adjacent to the gravel pads and landfall sites.

IV.C.9a.(1)(b) Effects of an Onshore Pipeline

For purposes of analysis, we assume vertical support members (pilings) would support the elevated onshore pipelines. The pipeline routes would include the following landfalls at either the existing facilities at Oliktok Point, Northstar landfall, West Dock, and the Badami Field for development in the Near Zone (Figure III.A-1); additional landfalls at either Bullen Point and Point Thomson for development in the Midrange Zone; and potential development for landfalls in the Far Zone at either Smith Bay for a western Beaufort Sea discovery or Point Thomson for an eastern Beaufort Sea discovery (Figure III.A-1). Onshore pipeline support members are assumed to be 12 inches in diameter and would be placed 55-70 feet apart. Workers would remove vegetation at each support member (about 70-100 beams per mile) along the elevated pipeline connecting to the existing pipeline. Less than 1 acre of vegetation would be removed along the 12- or 50-mile pipeline route for development projects in the Far Zone. The onshore pipeline route to Deadhorse-Prudhoe Bay would come from Smith Bay or Point Thomson for development in the Far Zone. Each beam would disturb about 2 inches of vegetation around it in addition to the vegetation it would directly affect (Jorgenson, 1997, as cited by U.S. Army Corps of Engineers. 1999). The disturbance zone would result from locally deposited spoil material and possible thermokarsting; it could change the composition of plant species. Each vertical beam would disturb about 1.4 square feet of vegetation, of which 6% would be destroyed or replaced. This would result in 0.0032 acres being disturbed per pipeline mile, or 0.0384-0.175 acre (0.0032 x 12 miles and 0.0032 x 50 miles).

Pipelines also could harm vegetation indirectly through snow drifting or shading. Any vegetation under a pipeline would receive less direct sunlight during the growing season, potentially leading to a shallower active layer in the soil and reduced photosynthesis by the plants. If this effect did occur, it would take place only along the 1.4-mile long pipeline.

IV.C.9.a(1)(c) Effects of Onshore Ice Roads

We assume that no interconnecting access roads would be built next to the onshore pipelines tying into the Trans-Alaska Pipeline System or existing pipelines. Much of the length of ice roads would be located offshore and routed from the one or two exploration platforms (in a given year) and from the eight production platforms. Ice roads tend to compress and flatten the vegetation under them, and compressed vegetation would be common along onshore ice roads to the gravel mine and to the freshwater lakes. Ice roads probably would melt later in spring than nearby tundra and green up later because of the ice cover, resulting in “green trails” along the ice roads. Compression would not kill the vegetation, and we expect it to recover within a few years. We assume that currently implemented stipulations on ice roads would be followed for Alternative I for Sales 186, 195, and 202.

IV.C.9.a(1)(d) Effects of a Small Onshore Oil Spill on Vegetation and Wetlands

Over the production life of the Beaufort Sea multiple sales, 82 small crude oil spills (3 barrels) and 157-202 small refined oil spills (average of 0.7 barrels) are estimated to occur (Tables A.1-6b and A.1-6e). These onshore spills likely would occur on the gravel pads near the tie-in locations and could have only a minimal effect on vegetation. Most spills occur on gravel pads and, consequently, their effects do not reach the vegetation. About 20-35% of past crude-oil spills have reached areas beyond pads. The corresponding proportion for refined oil spills probably is much less but, for purposes of analysis, it is assumed that 27% of all spills occur or reach beyond gravel pads. Because winter spans the majority of each year, most spills happen when there is sufficient snow cover so that cleanup efforts take place before the oil reaches the vegetation; this situation occurs during about 60% of the year. Thus, for purposes of analysis, it is assumed that 11% of all spills will affect vegetation.

Most spills cover less than 500 square feet (less than 0.01 acre) with a maximum coverage of 4.8 acres, if the spill is a windblown mist. For purposes of analysis, it is assumed that the average spill would cover 0.1 acre. Under Alternative I, the total area of vegetation that would be impacted by spilled oil over the lifetime of developed oil fields would be 0.5-2.6 acres. Overall, past spills on Alaska’s North Slope have caused minor ecological damage, and ecosystems have shown a good potential for recovery (Jorgenson, 1997).

Over the production life of the Beaufort Sea multiple-sale activities, 82 small crude oil spills (3 barrels) and 157-202 small refined oil spills (average of 0.7 barrel) are estimated to occur (Tables A.1-6b and A.1-6e). These minor spills could have an additive effect on tundra and coastal vegetation-wetlands, perhaps increasing contamination of vegetation-wetlands by less than 10 acres.

IV.C.9.a(2) Effects of a Large Oil Spill on Vegetation and Wetlands

The main potential effects on vegetation and wetlands include oil-fouling, smothering, asphyxiation, and poisoning of plants and associated insects and other small animals. Complete recovery of oiled wetlands could take perhaps 10 years or longer. A second main effect is the disturbance of wetlands from spill-cleanup activities. Complete recovery of oiled coastal wetlands from these disturbances could take several decades. Effects on coastal vegetation-wetlands would occur only if a spill occurred during the summer open-water season. In winter, bottomfast ice covers the lagoon and coastal shorelines, and snow buffers the oil from the tundra.

IV.C.9.a(2)(a) Effects of an Offshore Oil Spill

The mean number of one (1,500-barrel or 4,600-barrel) or more oil spills greater than or equal to 1,000 barrels occurring during exploration and development is 0.11. The most likely number of spills greater than or equal to 1,000 barrels is zero. In the unlikely event that such a spill occurs, the analysis assumes a platform spill of 1,500 barrels or a pipeline spill of 4,600 barrels (Table IV.A-5). Wetlands in coastal habitats from Dease Inlet, Cape Simpson east to Atigaru Point-Kogru River (Land Segments 26, 28-33, and 47), and the Kaktovik area (Land Segment 74) have the highest chance of contact to vegetation, greater than 15% up to 21%, during the summer season within 30 days (Table A.2-27 from either LA1-LA18 or P1-P13). Additionally, there is a 9-73% chance oil will contact the shoreline somewhere in the planning area within 30 days (Table A.2-21 contacts to Land). A spill of 1,500 barrels or 4,600 barrels could oil an estimated 29-49 kilometers of shoreline (Tables IV.A-6a and 6b) and extend onshore a few feet to several yards, depending on tides and storm surges. The shoreline of the planning area contains some habitats with fairly high values (1 being the lowest and 10 being the highest) for oil-spill retention (lagoonal beaches have a value of 5, and peat shores have a value of 6) along river deltas and near the mouths of rivers. Stranded oil on sheltered intertidal areas, especially along peat shorelines, is likely to persist for many years (Nummedal, 1980; Owens et al, 1983).

IV.C.9.a(2)(b) Effects of Offshore Oil Spills on Saltmarsh Vegetation and Invertebrate Communities

Heavy oiling of saltmarsh vegetation and insects and other small animals in the marshes would kill some plants through fouling, smothering, and asphyxiation and poisoning from direct contact with the oil (Zieman et al., 1984). Oil contamination stunts the growth of saltmarsh vegetation, mainly because it stays on the shoots; the effect depends on the amount of oiling and contamination (Scholten, Leendertse, and Blaauw, 1987). Sea grasses, however, have been shown to grow well under chronic, low-level exposure to hydrocarbons (McRoy and Williams, 1977). Diesel fuel is more toxic than crude oil and could kill more vegetation, but diesel fuel would evaporate more quickly and not persist in the saltmarsh.

The mean number of one or more oil spills greater than or equal to 1,000 barrels occurring during exploration and development is 0.11. The most likely number of spills greater than or equal to 1,000 barrels is zero. In the unlikely event that such a spill occurs, there is a less than 0.5-21% conditional chance that an offshore spill will contact coastline habitats in the planning area, which include wetlands and other vegetation cover. An estimated 29-40 kilometers of coastline could be oiled from a 1,500- or 4,600-barrel spill. The shoreline of the planning area contains some habitats with fairly high values (1 being the lowest and 10 being the highest) for oil-spill retention (lagoonal beaches have a value of 5, and peat shores have a value of 6) along river deltas and near the mouths of other streams. Stranded oil on sheltered intertidal areas, especially along peat shorelines, likely would persist for many years.

Conclusion: Disturbances mainly come from building gravel pads and ice roads and installing the onshore pipeline. Gravel pads, the pipeline trench, and the 12- or 50-mile-long onshore pipelines would destroy a few acres of vegetation and affect a few acres of nearby vegetation and have only local effects on the tundra ecosystem. Ice roads would have local effects (compression of tundra under the ice roads) on vegetation, with recovery expected within a few years, and no vegetation would be killed.

The mean number of one or more oil spills greater than or equal to 1,000 barrels occurring during exploration and development is 0.11. The most likely number of spills greater than or equal to 1,000 barrels is zero. In the unlikely event that such a spill occurs, there is a less than 0.5-21% conditional chance that an offshore spill will contact coastline habitats in the planning area, which include wetlands and other vegetation cover. An estimated 29-40 kilometers of coastline could be oiled from a 1,500- or 4,600-barrel spill. The shoreline of the planning area contains some habitats with fairly high values (1 being the lowest and 10 being the highest) for oil-spill retention (lagoonal beaches have a value of 5, and peat shores have a value of 6) along river deltas and near the mouths of other streams. Stranded oil on sheltered intertidal areas, especially along peat shorelines, likely would persist for many years.

Effectiveness of Mitigating Measures: The ITL - 5 Information on River Deltas and ITL - 11 Information on Sensitive Areas to be Considered in Oil-Spill-Contingency Plans could reduce potential oil-spill effects on coastal vegetation and wetlands by giving these habitats priority in protection from an oil spill through the use of booms to divert the spill away from the wetlands. However, the effectiveness of such measures would be determined by weather conditions during the time of the spill.

The ITL - 6 Information on Use of Existing Pads and Islands potentially could reduce the number of gravel pads onshore and reduced the amount of gravel needed for construction of new pads and islands. This measure potentially could reduce the amount of vegetation and wetlands that would be dug up or covered at gravel-mine sites and at pad locations.

These ITL clauses could minimize effects on vegetation and wetlands.

IV.C.9.b. Effects of the Alternatives for the Sales

IV.C.9.b(1) Effects of Alternative I for Sales 186, 195, and 202

The effects of Alternative I for Sales 186, 195, and 202 likely would be about the same as described in Section IV.C.9.a. Disturbances mainly come from gravel mining, building gravel pads and ice roads, and installing the onshore pipeline. Gravel mining, landfall gravel-pad construction, and onshore pipeline installation would destroy a few acres of vegetation and affect a few acres of nearby vegetation and have only local effects on the tundra ecosystem. Ice roads would have local effects (compression of tundra under the ice roads) on vegetation with recovery expected within a few years, and no vegetation would be killed. The effect of an oil spill on vegetation and wetlands would include oil fouling, smothering, asphyxiation, and poisoning of plants and associated insects and other small animals. Complete recovery of oiled wetlands would take perhaps 10 years or longer.

Under Alternative I for Sale 186, two production projects and 70% of the leasing activity are expected to occur in the Near Zone, which includes the nearshore area from about the east side of the Colville River Delta east to about Camden Bay (Map 4). One development project and 20% of the leasing activity likely would occur in the Midrange Zone, which extends from about offshore of Cape Halkett east to about Barter Island. Only 10% of leasing activity and no projects or industrial activity is expected to occur in the Far Zone, which extends west of Cape Halkett west to near Barrow and extends from near Barter Island east to the Canadian border (Map 4).

The effects of Alternative I for Sales 195 and 202 on vegetation-wetlands likely would be about the same as described for Sale 186, because the level of activities for Sales 195 and 202 are similar to the levels assumed for Sale 186.

Conclusion: The effects of Alternative I for Sales 186, 195, and 202 on vegetation and wetlands likely would include the destruction of some acres of vegetation-wetlands from gravel mining, landfall gravel-pad and onshore pipeline installation, and potential oil-spill effects and spill-cleanup effects, which could persist for 10 years or longer.

IV.C.9.b(2) Effects of Alternatives III through VI for Sales 186 and 195 and III through V for Sale 202

The effects of these alternatives on vegetation-wetlands likely would be about the same as described under Alternative I for any of these sales, because the level of activities are similar for the alternatives in both sales.

IV.C.9.b(3) Effects of Alternative VI for Sale 202

This alternative potentially could reduce oil-spill effects on coastal vegetation-wetlands, and potential onshore habitat effects from gravel mining, gravel pads, and onshore pipeline installation in the following areas would be avoided.

Under Alternative VI for Sale 202, potential onshore habitat effects could be avoided from about the Canning River east to Demarcation Bay and potential onshore habitat effects from gravel mining, gravel pads, and onshore pipeline installation in this area. The chance of contact to vegetation-wetland coastal habitats from about Beaufort Lagoon east to Herschel Island (Land Segments 49-55 within 30 days during the summer) would be reduced (2-11%), if oil exploration and development were deferred under this alternative (Table A.2-27, LA18). However, the chance of contact to coastal habitats west of Beaufort Lagoon (Table A.2-27, Land Segments 25-48) would be about the same as described under general effects.

Potential oil-spill and habitat effects on vegetation and west of the Alternative VI area would be the same as described under Alternative I for Sale 202.

Conclusion: While the effects on coastal vegetation and wetlands in the central Beaufort area could be reduced by Alternative VI for Sale 202, similar levels of activities to Alternative I for Sale 202 still would occur elsewhere and the overall effects vegetation and wetlands likely would be about the same as described under Alternative I for Sale 202.

IV.C.10. Economy

All of the alternatives, except Alternative II - No Lease Sale Alternative, for each of the proposed sales (186, 195, and 202) assume the same amount of oil and, for purposes of economic analysis, the levels of activity among alternatives and sales are very similar. Therefore, the economic effects to communities and to the State of Alaska are essentially the same. The analysis that follows focuses on the economic effects and does not follow the format used by the other resources evaluated in this section.

If any of the sales occur, they would generate economic activity manifested primarily in revenue to government, employment, and personal income. The economic effects would be in the North Slope Borough, Southcentral Alaska and Fairbanks, and the rest of the U.S. The exploration and development scenario in Section IV.A.1 and Appendix A is the basis for analysis of potential economic effects in this section. The reader should refer to these sections for a description of timing of OCS activity including infrastructure of wells, rigs, platforms, pipelines, and shore bases. The activities and construction and operation of infrastructure described in the exploration and development scenario generate the economic activity.

Economic effects would not exceed the significance threshold. Section IV.A defines the significance threshold for economics as effects "that will cause important and sweeping changes in the economic well-being of the residents or the area or region. Local employment is increased by 20% or more for at least 5 years." The term "local employment" here means workers who are permanent residents of the North Slope Borough, both Inupiat and non-Inupiat, and does not include North Slope oil industry workers who commute to residences within or outside of Alaska.

IV.C.10.a. Revenues and Expenditures

If held, each of the sales would generate increases in North Slope Borough property taxes averaging about 1% above the level of Borough revenues without the sales in the early years and taper off to less than 0.5% in the latter years. This increase would occur for each sale (186, 195, and 202). For each sale, the revenue to the North Slope Borough would be about $2.5 million in the first year of production, tapering off to $0.5 million in the later years.

In the early years of production, each of the sales would generate increases in revenues to the State of Alaska of less than 0.25% above the level without the sales. The increases would taper off to an even smaller percentage in the latter years of production. This increase would occur for each sale (186, 195, and 202). For each sale, the revenue to the State would be about $50 million in the first year of production, tapering off to $4 million in the latter years.

In the early years of production, each of the sales would generate increases in revenues to the Federal Government of less than 0.001% above the level without the sales. The increases would taper off to an even smaller percentage in the latter years of production. This increase would occur for each sale (186, 195, and 202). For each sale, the revenue to the Federal Government would be about $165 million in the first year of production, tapering off to $12 million in the latter years.

These revenue forecasts are based in part on the Liberty final EIS (USDOI, MMS, Alaska OCS Region, 2002a). That forecast is based on barrels of production. We took the ratio of revenue to barrels and applied it to the barrels forecast, which is the same for Sales 186, 195, and 202.

IV.C.10.b. Employment and Personal Income (Not Related to Oil Spills)

Each of the sales would generate employment and personal income in three major phases: exploration, development, and production. In general, employment and associated personal income would be at a relatively low level in exploration, peaking during development, and dropping to a plateau in production. This pattern of economic effect reflects the exploration and development scenario described in Section IV.A.1 and Appendix A. All direct OCS workers are assumed to work in enclaves on the North Slope during their work time and commute to residences elsewhere in their time off. Their place of residence during the time they are not in an OCS worker enclave would be in villages of the North Slope Borough or in Southcentral Alaska or Fairbanks, as indicated in Table IV.C-2. Additional workers on the North Slope commute to residences outside the State. Approximately 30% of current North Slope workers in the classification of oil and gas workers commute to locations outside Alaska (Hadland, 2002, pers. commun.; Hadland and Landry, 2002). However, the workers commuting to residences outside the State would not generate economic effects of indirect and induced employment or expenditure of income in the State, and they would have a negligible effect on the economy of the rest of the U.S. All of the commuting workers would be present at new OCS enclaves offshore or in associated enclave-support facilities in and near the Prudhoe Bay complex approximately half of the days in any year.

For Sale 186, the forecast increase of total employment and personal income is shown in Table IV.C-2. The change is less than 2% over the 1999 baseline for the North Slope Borough or the rest of Alaska for each of the three major phases of OCS activity. Abandonment of production facilities is technically an activity separate from production. However, for the sake of simplicity of presenting data in Table IV.C-2, production includes abandonment. Employment and personal income generated by abandonment would be small compared to production and would last only 2 years. Abandonment also is known as decommissioning.

Sale 195 would generate employment and personal income that is about 10% more than Sale 186 for exploration and development stages, but production would be only slightly higher. This is because the scenario for Sale 195 indicates activity in deeper water and farther from shore than Sale 186. Exploration and development activities require more workers, which in turn, generate more income.

Sale 202 would generate employment and personal income that is about 30% more than Sale 186 for exploration and development stages, but production would be only slightly higher. The reason for this increase is the same as for the differences between Sales 195 and 186. Sale 202 also includes 50 miles of offshore pipeline. Even with these increases, the increase of total employment and personal income for Sale 195 and Sale 202 would not exceed 3% over the 1999 baseline for the North Slope Borough or the rest of Alaska for each of the three major phases of OCS activity.

Sale 186 also would generate total employment and personal income in the rest of the U.S. approximately equal to workers residing in Southcentral Alaska and Fairbanks, as indicated in Table IV.C-2. The change for the rest of the U.S. would be less than 0.001% for all three phases of activity. This also is true for Sales 195 and 202. The exploration and development scenario for Sale 186 indicates exploration activity would take place in 2004-2010, development activity in 2009-2016, and production in 2010-2033. Abandonment of production facilities would start at the end of production for each of the fields in 2025, 2027, and 2033. Abandonment would take place over a 2-year period. The pattern for Sales 195 and 202 is similar to Sale 186. Each lease sale has some overlap of the three main activities of exploration, development, and production. To simplify analysis but define the primary distinctions, data for employment and personal income are presented as annual averages for the three main OCS activity categories.

For Alternatives III through VI, the economic effects would be the same as Alternative I for Sale 186. For purposes of economic analysis, we assume that the full exploration and development scenario for each of the deferral alternatives would occur as for Sale 186. That is, the OCS activity would take place in a different area and be the same for each deferral alternative as for Sale 186. These increases would occur for each sale (186, 195, and 202) for Alternatives III through VI.

For Alternative II No Action (i.e., not having Sale 186), the economic effect would be a loss of: $15 million in revenue to the North Slope Borough, $190 million to the State of Alaska, and $930 million to the Federal Government; an average of 800 jobs for 30 years; and a total of $1.7 billion of total personal income for these workers. This Alternative also would result in a shorter lifespan for the Trans-Alaska Pipeline.

"Direct employment" includes those workers with jobs directly in oil and gas exploration, development, and production. "Indirect employment" includes those workers in industries that support the direct exploration, development, and production activities. These include jobs in transportation, such as shuttling workers by air between Anchorage and the North Slope. Direct and indirect workers spend a part of their earnings for expenses such as food, housing, clothing, etc. The aggregate of workers associated with providing those goods and services is termed "induced employment." Each of the direct, indirect, and induced workers has compensation derived from their work defined as "personal income" in Table IV.C-2.

The direct workers residing in the North Slope Borough who are forecast in Table IV.C-2 represent about 5-10% of the total of the workers resident in Southcentral Alaska and Fairbanks. This is an increase from the early 1990s total of about 1%. All of the Borough residents forecast are assumed to be Alaska Natives. This is based on research in 1999 (Jack Faucett Assocs., Inc., 2000). We acknowledge that forecasting North Slope Borough Native residents working in OCS activities is particularly conditional given past history. See Section III.C.1 for a further discussion of past history of North Slope Borough Natives working in the North Slope oil industry.

Because of the development of facilities or the continued use of facilities onshore that are taxable by the North Slope Borough, the Borough will have additional revenues available that most will be used for its ongoing operations. This, in turn, results in North Slope Borough government jobs. This is in large part how the indirect and induced jobs are generated in the North Slope Borough.

IV.C.10.c. Employment Related to Spills

In the unlikely event of a large oil spill of 1,500 barrels, we estimate employment to clean it up to be 60 cleanup workers for 6 months in the first year, declining to zero by the third year following the spill. In the unlikely event of a large spill of 4,600 barrels, we estimate employment to be 190 cleanup workers for 6 months in the first year, declining to zero by the third year following the spill. This is for each sale (186, 195, and 202). The 60-190 workers make up about 0.6-1.9% of the workers who cleaned up the *Exxon Valdez* oil spill. For an analysis of spill sizes, see Section IV.A.4.

Our estimate of employment to clean up spills is based on the most relevant historical experience of a spill in Alaskan waters, the *Exxon Valdez* oil spill of 1989. That spill was 240,000 barrels. It generated enormous employment that rose to the level of 10,000 workers directly doing cleanup work in relatively remote locations. Smaller numbers of cleanup workers returned in the warmer months of each year following 1989 until 1992. Numerous local residents quit their jobs to work on the cleanup at often significantly higher wages. This generated a sudden and significant inflation in the local economy (Cohen, 1993). Similar effects on the North Slope Borough would be mitigated due to the likelihood that cleanup activities, including administrative personnel and spill-cleanup workers, would be located in existing enclave-support facilities. In the unlikely event of a 1,500-4,600-barrel oil spill, the number of workers actually employed to clean it up would depend on a number of factors. These include the procedures called for in the oil-spill-contingency plan, how well prepared with equipment and training the entities responsible for cleanup were, how efficiently the cleanup was executed, and how well coordination of the cleanup was executed among numerous responsible entities.

IV.C.10.d. Trans-Alaska Pipeline

Sale 186 would produce 460 million barrels of oil over 23 years of production. This oil probably would extend the useful life of the Trans-Alaska Pipeline. The same is true for sales 195 and 202.

IV.C.10.e. Stipulations and Information to Lessees

The 5 standard stipulations and 16 ITL clauses would not change the effects analyzed.

IV.C.10.f. Subsistence as a Part of the North Slope Borough Economy

The predominately Inupiat residents of the North Slope Borough traditionally have relied on subsistence activities. Although not fully part of the cash economy, subsistence hunting is important to the Borough's whole economy, and even more important to culture. For the analyses of effects on these activities, see Sections IV.C.11 - Subsistence-Harvest Patterns and IV.C.12 - Sociocultural Systems.

Conclusion. Each of the Sales (186, 195, and 202) would generate increases in North Slope Borough property taxes that would average about 1% above the level of Borough revenues without the sales in the early years and taper off to less than 0.5% in the latter years. In the early years of production, each sale would generate increases in revenues to the State of Alaska of less than 0.25% above the same level without the sale. The increases would taper off to an even smaller percent in the latter years of production. The change in total employment and personal income is less than 2% over the 1999 baseline for the North Slope Borough and the rest of Alaska for each of the three major phases of OCS activity. The three major phases are exploration, development, and production. The employment and personal income increase includes workers to clean up possible large oil spills of 1,500 barrels and 4,600 barrels. Increases in employment and personal income for Sales 195 and 202 would be less than 3% over the 1999 baseline. Sales 186, 195, and 202 probably would extend the lifespan of the Trans-Alaska Pipeline.

For Alternatives III through VI, the economic effects would be the same as for Alternative I for Sales 186, 195, and 202. For purposes of economic analysis, we assume that the full exploration and development scenario for each of the deferral alternatives would occur as for Sale 186. That is, the OCS activity would take place in a different area and be the same for each deferral alternative as for Sale 186. These increases would occur for each sale (186, 195, and 202) for Alternatives III through VI.

For Alternative II No Lease Sale (not having Sale 186. 195, or 202), the economic effect would be a loss of: $15 million in revenue to the North Slope Borough, $190 million to the State of Alaska, and $930 million to the Federal Government; an average of 800 jobs for 30 years; and a total of $1.7 billion of total personal income for these workers. This Alternative would result in a shorter lifespan for the Trans-Alaska Pipeline.

IV.C.11. Subsistence-Harvest Patterns

IV.C.11.a. Introduction

This section analyzes the effects of Alternative I for Sales 186, 195, and 202 on subsistence-harvest patterns of communities near the proposed Beaufort Sea multiple-sale area. This analysis is organized by types of effects and by subsistence resource and discusses effects on subsistence-harvest patterns from oil spills, and noise and disturbance activities. The discussion of effects on subsistence-harvest patterns that follows this analysis is organized by community. Analytical descriptions of affected resources and species in addition to indigenous Inupiat knowledge concerning effects are described in detail.

Effects on communities outside of the lease-sale area are not discussed in this analysis because: (1) effects of noise and disturbance on subsistence are very localized and would not affect the subsistence harvests of Alaskan (or Canadian) communities other than Barrow, Nuiqsut, and Kaktovik; (2) it is extremely unlikely that an oil spill would contact subsistence-harvest areas of Alaskan (or Canadian) communities other than Barrow, Kaktovik, and Nuiqsut; and (3) pipelines would be constructed only in the lease-sale area, and effects from construction would be localized.

The Beaufort Sea multiple-sale area includes the eastern portion of the marine subsistence-resource area of Barrow and the entire marine subsistence-resource areas of Nuiqsut and Kaktovik. Moreover, if economically recoverable amounts of oil were discovered, onshore pipelines and roads associated with development could affect the terrestrial subsistence resources that are harvested by these three coastal communities in addition to the inland community of Atqasuk.

As noted in Sections III.C.2 and 3, onshore oil developments at Prudhoe Bay already have affected the subsistence-harvest system. Many of these effects are the indirect result of increased wage employment made available through projects and services funded by the North Slope Borough. Wage employment has led to an upgrading of hunting technology; alternatively, it has constricted the total time available for hunting. Additionally, Prudhoe Bay development has restricted access to traditional hunting areas in the vicinity. Currently, diminished household incomes, reduced by the loss of high earnings from the North Slope Borough Capital Improvements Projects period in the early to mid-1980's, tend to encourage subsistence-hunting activity and to foster an increase in harvest levels and an expansion of subsistence-harvest areas for many subsistence resources (Pedersen, 1997). Another effect on subsistence-harvest patterns has been the alteration of use areas due to Prudhoe Bay development. Pedersen (1998, pers. commun.) has indicated that Nuiqsut residents have altered their use patterns around Prudhoe Bay, and Nuiqsut residents confirm this. Another major change has been increased access to Deadhorse, via the haul road and beyond, provided by a winter ice road that has connected Nuiqsut and Prudhoe Bay for the last few years.

IV.C.11.a(1) Effects Agents

Access to subsistence resources, subsistence hunting, and the use of subsistence resources could be affected by reductions in subsistence resources and changes in subsistence-resource-distribution patterns. These changes could occur as a result of oil spills and noise and disturbance from seismic surveys; aircraft and vessel traffic; drilling activities; pipeline construction; structure placement; and support-base, pump-station, and gravel- and ice-road construction. The following analysis examines the effects of each of these disturbance agents on the subsistence resources harvested by the Inupiat living in the communities near the Beaufort Sea multiple-sale area. This analysis includes the marine and terrestrial resources harvested by the residents of Barrow, Nuiqsut, and Kaktovik. Atqasuk residents also harvest marine mammals, but only in conjunction with Barrow whaling crews. All subsistence-harvest effects on marine mammals in Barrow also would occur in Atqasuk.

IV.C.11.a(2) Factors Affecting Subsistence-Harvest Patterns in Barrow, Nuiqsut, and Kaktovik

The factors affecting the subsistence-harvest patterns of Barrow, Nuiqsut, and Kaktovik are summarized as follows (the information on harvests is taken from records of annual subsistence-resource harvests averaged over 20 years [Stoker, 1983, as cited by ACI/Braund, 1984; S.R. Braund, 1989a; State of Alaska, Dept. of Fish and Game, 1993a,b]):

- Heavy reliance on caribou in the annual average harvest for Barrow (22-58% of the total subsistence harvest), Nuiqsut (30-37%), and Kaktovik (11-16%). (See Tables III.C-8, III.C-9, III.C-10, III.C-11, III.C-12, III.C-13, III.C-15, and III.C-16; ACI/Braund, 1984; S.R. Braund,1989b; State of Alaska, Dept. of Fish and Game, 1995d; S.R. Braund and Assocs. and UAA, ISER, 1993; Pedersen, 1995a,b; S.R. Braund and Associates, 1996; Brower and Opie, 1997; Opie, Brower, and Bates, 1997; Brower, Olemaun, and Hepa, 2000).
- Heavy reliance on bowhead whales in the annual average harvest for Barrow (21-38% of the total subsistence harvest), Kaktovik (27-63%), and Nuiqsut (4-38%). (See Tables III.C-8, III.C-9, III.C-10, III.C-11, III.C-12, III.C-13, III.C-15, and III.C-16). Percentages have continued to rise because International Whaling Commission quotas have almost doubled in recent years (ACI/Braund, 1984; S.R. Braund and Assocs. 1989, 1996; North Slope Borough Planning Dept., 1993; Kaleak, 1996; Brower and Opie, 1997; Brower, Olemaun, and Hepa, 2000; State of Alaska, Dept. of Fish and Game 1995a,b; Stephen R. Braund and Assocs. and UAA, ISER, 1993; Pedersen, 1995a,b).
- Reliance on fish in the annual average harvest for Barrow (6-7% of the total subsistence harvest), Nuiqsut (33-44%), and Kaktovik (13-22%). (See Tables III.C-8, III.C-9, III.C-10, III.C-11, III.C-

12, III.C-13, III.C-15, and III.C-16; S.R. Braund and Assocs. 1989b; State of Alaska, Dept. of Fish and Game, 1995d; Brower and Opie, 1997; Opie, Brower, and Bates, 1997; Brower, Olemaun, and Hepa, 2000).

Subsistence-hunting areas overlap for many species harvested by Barrow, Nuiqsut, and Kaktovik.

Hunting and fishing are cultural values that are central to the Inupiat way of life and culture. Barrow, Nuiqsut, and Kaktovik all are Inupiat villages chiefly depending on subsistence resources. In 1990, the population of Barrow was 3,469; Nuiqsut, 354; and Kaktovik, 224; in 2000, the population of Barrow was 4,581; Nuiqsut, 433; and Kaktovik, 293.

IV.C.11.a(3) The Cultural Importance of Subsistence

Eugene Brower testified in Barrow at the public teleconference for our draft EIS on the 1997-2002 5-Year Oil and Gas Leasing Program for the OCS. He asserted the importance of the subsistence harvest to Inupiat lifeways in the Chukchi and Beaufort Seas:

> These two oceans produce the main food supply for the Inupiat people living off the two oceans. And these two oceans are our garden. They may not produce oranges or apples or sauerkraut or cauliflower, cattle, or chicken, but they produce the food that keeps us alive. You may not like how we eat it, but the good Lord put these animals in this region so that we, The Inupiat, can live off these animals (Brower, 1996, as cited in USDOI, MMS, 1996e).

Frank Long, Jr., President of the Nuiqsut Whaling Captains Association, expressed the importance of the bowhead whale hunt to the Inupiat way of life at an Arctic Synthesis Meeting we convened in Anchorage, Alaska, in 1995:

> We know that whaling is dangerous, but it is our livelihood. We have to supply our community's nutritional needs for the winter. The captain doesn't get the whole whale; after it is harvested, it belongs to the whole community. We share it? (Long, 1996).

In 1994, Glenn Roy Edwards, whaler and Arctic Slope Regional Corporation official, related:

> Without whaling, there would be no purpose to Barrow. I depend on my job; I like my job. But if it came down to a choice, I'd leave it to come out here and go whaling. I am first a whaler (Balzar, 1994).

IV.C.11.a(4) Effects Definitions and Effects Levels

The assessment of effects levels derives from a set of effects-level definitions that have been developed over many years by MMS anthropologists and socioeconomic specialists and have withstood many professional and legal reviews. These definitions follow a two-tiered approach in that they account for effects to subsistence resources in addition to effects to subsistence harvests. Disturbance to subsistence is measured by the duration of effect to resources and harvests and by changes in availability, in desirability, and in resource population levels. The definitions used in this analysis consider periodic (short-term) effects to resources that have no consequent effects to harvests as the lowest level of effect (very low effect). The next level of effect has resources being affected for a period up to 1 year (1 harvest season); but none of these resources would become unavailable, undesirable, or experience population reductions and, therefore, would not alter subsistence harvests (low effect). The third gradation of effect has resources becoming unavailable, undesirable for use, or experiencing population reductions for a period up to 1 year (1 harvest season), with subsistence harvests being affected for that period (moderate effect). The next level of effect is similar to the previous definition, except resources would become unavailable, undesirable for use, or experience population reductions for a period of 1-2 years (2 harvest seasons), with subsistence harvests affected for a longer period (high effect). The highest level of effect follows the structure of the previous two effects levels with resources becoming unavailable, undesirable for use, or experiencing population reductions for a period of from 2-5 years (5 harvest seasons), with subsistence harvests affected for a much longer period (very high effect).

IV.C.11.b. Effects Common to All Alternatives

IV.C.11.b(1) Effects from Routine Operations

IV.C.11.b(1)(a) Effects from Disturbances, Discharges, and Small Oil Spills

The noise-producing exploration and construction activities are those most likely to produce disturbance effects on critical subsistence species that include bowhead and beluga whales, caribou, fish, seals, and birds. Another detailed narrative of the effects from these activities on important subsistence species can be found in Section IV.B.10 of the Beaufort Sea Sale 144 final EIS (USDOI, MMS, 1996a). Disturbance effects would be associated with aircraft and vessel noise, construction activities, and oil spills; specifically: (1) seismic surveys that occur prior to an oil and gas lease sale; (2) aircraft support of exploration and development activities; (3) possible vessel supply and support of exploration and development activities; (4) drilling activities during the exploration and development and production phases; and (5) onshore construction, including pipeline, road, support-base, landfall, and pump-station construction. Noise and traffic disturbance would be a factor throughout the life of the sale.

Disturbance from construction activities could cause some animals to avoid areas in which they normally are harvested or to become more wary and difficult to harvest. The latter could be a concern during the bowhead whale migration offshore, although possible supply-barge traffic to coastal staging areas would tend to follow a nearshore route and likely would occur during the summer, when whales are not present. Current Western scientific research indicates bowheads do not seem to travel more than a few kilometers out of their original swimming direction due to noise-disturbance events, and that these changes in swimming direction are temporary, lasting from a few minutes for aircraft and vessel noise to up to 1 hour in response to seismic activity. Traditional Inupiat observation and experience affirms that whales are affected by noise at greater distances and alter their swimming directions for longer periods. In some instances, as in the case of nesting birds, construction activities may decrease the biological productivity of an area. Restrictions may be placed on the use of firearms in areas surrounding new oil-related installations (such as roads, landfalls, and pipelines) to protect oil workers and valuable equipment from harm. Structures such as pipelines may limit hunter access to certain active hunting sites.

IV.C.11.b(1)(b) Specific Effects on Subsistence Resources

IV.C.11.b(1)(b)1) Bowhead Whales

Aircraft flying above 300 meters (984 feet) have little effect on bowhead whales. Below this altitude, some changes in whale behavior may occur, depending on the type of plane and the responsiveness of the whales present in the vicinity of the aircraft. The effects from an encounter with either fixed-wing aircraft or helicopters generally are brief, and the whales normally resume their activities within minutes. Bowheads may exhibit temporary avoidance behavior if approached by vessels at a distance of 1-4 kilometers (0.62-2.5 miles). Marine-vessel traffic also may include seagoing barges transporting equipment and supplies from Southcentral Alaska to the drilling location, most likely between mid-August and mid- to late September. If barge traffic continues into September, some bowheads may be disturbed. Fleeing behavior from vessel traffic generally stops within minutes after the vessel passes, but scattering may persist for a longer period. In some instances, at least some bowheads return to their original locations. In many cases, vessel activities are likely to be in shallow, nearshore waters outside the main bowhead-migration route.

Many studies indicate that most bowheads exhibit avoidance behavior when exposed to sounds from seismic activity at a distance of a few kilometers but rarely show avoidance behavior at distances of more than 7.5 kilometers (4.7 miles). Under these conditions, bowheads also exhibit tendencies for reduced surfacing and dive duration, fewer blows per surfacing, and longer intervals between successive blows. Bowheads appear to recover from these behavioral changes within 30-60 minutes after seismic activity stops. However, recent monitoring studies (1996-1998) indicate that during the fall migration, most bowhead whales avoid an area around a seismic vessel operating in nearshore waters by a radius of about 20 kilometers. The sighting rates of whales at a radius of 20 and 30 kilometers was higher than the sighting rate within the 20-kilometer radius, but it varied annually from no evidence of a reduced sighting rate in 1996 to a reduced sighting rate in 1998. This is a larger avoidance radius than was observed from scientific studies conducted in the 1980's. Avoidance did not persist beyond 12 hours after the end of seismic operations.

Exploratory drilling from gravel islands generally is conducted during the winter. Should these activities occur during the bowhead migration, noise produced is not expected to affect whales, because gravel islands are constructed in fairly shallow water shoreward of the main migration route, and noise from operations on gravel islands generally is not audible beyond a few kilometers. Exploratory drilling from bottom-founded structures also generally is conducted during the winter. Bowheads have been sighted within 0.2-5 kilometers (0.12-3 miles) from drillships, although some bowheads probably change their migration speed and swimming direction to avoid a close approach to noise-producing activities. A few bowheads may avoid drilling noise at 20 kilometers (12.4 miles) or more. If icebreakers attend drillships, as is typically the case during the fall in the U.S. Beaufort Sea, drillship noise frequently may be masked by icebreaker noise, which often is louder. There are no observations of bowhead reactions to icebreakers breaking ice, but it has been predicted that roughly half of the bowheads would respond at a distance of 4.6-20 kilometers (2.86-12.4 miles) when the signal-to-noise ratio is 30 decibels. Whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources.

Island-construction activities likely would be conducted during the winter and generally are in nearshore shallow waters shoreward of the main bowhead whale-migration route. These activities are not expected to affect bowhead whales. Some whales may be displaced seaward, if cleanup activities occurred outside the barrier islands or in the channels between the barrier islands during the whale migration.

Bowheads do not seem to travel more than a few kilometers in response to a single disturbance incident, and behavioral changes are temporary, lasting from few minutes, in the case of vessels and aircraft, to up to 30-60 minutes, in the case of seismic activity in earlier seismic studies. In recent studies, avoidance of an area within 20 kilometers of seismic operations did not persist beyond 12 hours after seismic operations had stopped. Occasional and brief interruption of feeding by a passing vessel or aircraft probably is not of major significance. Similarly, the energetic cost of traveling a few additional kilometers to avoid closely approaching a noise source is very small in comparison with the cost of migration between the central Bering and eastern Beaufort seas. We do not believe these disturbance or avoidance factors will be significant, because the level of industrial activity anticipated is not sufficiently intense to cause repeated displacement of specific whales. Reactions are less obvious in the case of industrial activities that continue for hours or days, such as distant seismic exploration and drilling. Behavioral studies have suggested that bowheads habituate to noise from distant ongoing drilling or seismic operations (Richardson et al., 1985a), but there still is some apparent localized avoidance (Davis, 1987). There is insufficient evidence to indicate whether or not industrial activity in an area for a number of years would adversely impact bowhead use of that area (Richardson et al., 1985b), but there has been no documented evidence that noise from OCS operations would serve as a barrier to migration.

Overall, bowhead whales exposed to noise-producing activities such as vessel and aircraft traffic, drilling operations, and seismic surveys most likely would experience temporary, nonlethal effects, and some avoidance behavior could persist up to 12 hours.

Nuiqsut whaling captain Frank Long, Jr., stated that oil-industry activity offshore has affected not only whales but also seals and birds (Long, as cited in National Marine Fisheries Service, 1993). Expressing concern about aircraft disturbance, a Nuiqsut resident and whaling captain said in recent testimony for an offshore lease sale that seismic traffic and helicopter overflights "were the cause of whales migrating farther north out to the ocean, 20 miles farther north than their usual migration route" (USDOI, MMS, 1995a). Earlier, Patsy Tukle from Nuiqsut had expressed this same sentiment. He explained that ships and helicopters are interfering with whale hunting even though they are not supposed to. He affirmed the need to enforce controls so whaling may go on unimpeded (Tukle, 1986, as cited in USDOI, MMS, 1986a). To show that aircraft disturb bowhead whales, Kaktovik resident Susie Akootchook related her observations while counting whales in Barrow:

> I worked with the whale census and worked with Chris Clark that time they did the whale census over at Barrow. And I was with the acoustic crew listening in with speakerphones and those microphones were like a 100, 75 to 50 feet under. And if you guys are planning on using your choppers, there is going to be a lot of noise. One time I was on a ship, and I had the headsets on and then heard an airplane. Mind you, from under the water, listening in, I can hear an airplane

> flying over. From that end of the mike to that end of the mike, I could hear it all the way clear. And when I went out there and checked, it was way up there. And that noise, whether you use choppers or airplanes, it's going to be disruptive" (Akootchook, 1996, as cited in Dames and Moore, 1996b).

Thomas Napageak, President of the Native Village of Nuiqsut and Alaska Eskimo Whaling Commission Chairman, related in 1979 that he had not seen one whale while going to Cross Island every year and believes it is the result of seismic activity in the area (Napageak, 1979, as cited in USDOI, Bureau of Land Management, 1979a). Maggie Kovalsky from Nuiqsut, testifying in 1984 on Endicott development, explained that with all the noise and activities, bowhead whales that migrate not far from that area all the way to Canada probably will be hurt (Kovalsky, 1984). In a Statewide survey by the Alaska Department of Fish and Game, Division of Subsistence from 1992-1994, 86.7% of the respondents in Nuiqsut believed that there were fewer marine mammals as a result of development on the outer continental shelf (State of Alaska, Dept. of Fish and Game, 1995a). At a village meeting for the Northstar Project in 1996, Nuiqsut residents said they feared effects from the project, because it was in the migratory path of the bowhead whales. They made it clear that seismic and transportation noise are of primary concern to Beaufort Sea residents for their impacts on bowhead whales (Dames and Moore, 1996a).

The MMS is conducting long-term environmental monitoring in the region and, as part of this effort, has begun a multiyear collaborative project with Nuiqsut whalers that will describe present-day subsistence whaling practices at Cross Island to empirically verify any changes to whaling due to weather, ice conditions, and oil and gas activities. After the first field season in 2001, Nuiqsut whalers reported the following changes in whale behavior and whaling practices:

- fewer whales in smaller groups were seen;
- the need to travel farther from Cross Island to find whales;
- whales observed were more skittish than in previous years and stayed more in the ice than in open water, spent more time on the surface, and followed more unpredictable paths underwater;
- whales were more difficult to spot because blows were not as observable as in past years; and
- whales appeared to be skinnier.

Possible causes suggested by the whalers for these behavioral changes were:

- Offshore seismic survey work for the natural gas-pipeline route;
- Barge supply traffic to Kaktovik for a water- and sewer-construction project;
- The presence of killer whales offshore and to the east of Cross Island;
- Ice conditions in Canadian waters; and
- Air and water traffic to the east of Cross Island (Galginaitis, 2003).

In 1979, Kaktovik residents were concerned about disturbance of migrating whales from drilling noise. Whaling captain James Killbear expressed this concern (Killbear, 1979, as cited in USDOI, Bureau of Land Management, 1979b). Herman Aishanna, former mayor, vice mayor, and head of Kaktovik's Whaling Captains' Association, maintained that in 1985 the single steel drilling caisson did affect the whale subsistence hunt even though it was idle. He reported: "We got no whales that year" (Aishanna, as cited in National Marine Fisheries Service, 1993). Fenton Rexford, President of Kaktovik Inupiat Corporation (KIC; Kaktovik's village corporation), stated that during exploratory drilling in Canadian offshore waters, "We were not successful or had a very hard time in catching our whale when there was activity with the single steel drilling caisson, the drilling rig off Canada. And it diverted [bowhead whales] way offshore; made it very difficult for our whalers to get our quota" (Rexford, as cited in USDOI, MMS, 1996d). At the MMS Information Update Meeting held March 29, 2000, in Barrow, the Alaska Department of Fish and Game made a presentation on a draft study of subsistence economics and oil development in Nuiqsut and Kaktovik, which affirmed a strong connection to anthropogenic effects as the cause of Kaktovik's unsuccessful whaling season in 1985 (Pedersen et al., In prep.). Sometimes grounded ice can keep whalers from reaching bowhead whales—such a situation was reported in September 1985; but the timing of such events is critical. A blockage before or after most of the whales have migrated past the community would have less effect on the success of the hunt than a blockage during the peak migration. Speaking about the disappointing spring hunt in 1978, when only four whales were caught, Thomas Brower, Sr., from Barrow explained:

> The gravel island drilling at this time may make it impossible for the [whaling] captains to supply [the village] with needed winter food supplies. The gravel island drilling at this time may make it impossible for the captains to fill this need for adequate nutrition for the long Arctic winter (North Slope Borough, Commission on History and Culture, 1980).

Charles Okakok from Barrow spoke out against drilling because he believed, as many Inupiat subsistence whalers believe and have observed that the noise may be detrimental to the bowhead whale hunt (Okakok, 1990, as cited in USDOI, MMS, 1990b). Barrow resident Arthur Neakok maintained that ice presents an extreme hazard to ships and drilling (Neakok, 1990, as cited in USDOI, MMS, 1990b). At the same hearing, Eugene Brower expressed concern that multiyear ice would cause problems during drilling (Brower, 1990, as cited in USDOI, MMS, 1990b).

Herman Rexford from Kaktovik recounts that oil ships affect the migration of the whales. He would like to see no ships or exploration at Kaktovik during the fall whaling time. He knows that the ships are noisy and can affect whaling routes (Rexford, 1986, as cited in USDOI, MMS, 1986b. Herman Aishanna, Kaktovik vice mayor, recounted that "tugs make a lot of noise in the summertime" (Aishanna, 1996, as cited in Dames and Moore, 1996c). Thomas P. Brower, Sr., from Barrow, began whaling as a boy in 1917. He stated in a 1978 interview that:

> The whales are very sensitive to noise and water pollution. In the spring whale hunt, the whaling crews are very careful about noise. In my crew, and in other crews I observe, the actual spring whaling is done by rowing small boats, usually made from bearded sealskins. We keep our snow machines well away from the edge of the ice so that the machine sound will not scare the whales. In the fall, we have to go as much as 65 miles out to sea to look for whales. I have adapted my boat's motor to have the absolute minimum amount of noise, but I still observe that whales are panicked by the sound when I am as much as 3 miles away from them. I observe that in the fall migration the bowheads travel in pods of 60 to 120 whales. When they hear the sound of the motor, the whales scatter in groups of 8 to 10, and they scatter in every direction. (North Slope Borough, Commission on History and Culture, 1980).

The recently published study Bowhead Whale Feeding in the Eastern Beaufort Sea: Update of Scientific and Traditional Information, contracted by the MMS, records a great deal of traditional knowledge of the local Kaktovikmiut (Kaktvik) whalers. Whaling knowledge pointed out the following:

- The historic core whaling area extends from the Hulahula River in the west to Tapkaurak Point in the east and offshore as far as 20 miles;
- Most whales are taken within 18-19 miles of the village;
- The mean distance of harvest locations from Kaktovik has not changed from the 1970's to the present;
- Whaling captains select small whales over large whales;
- Whalers have noted a significant decrease in the average size of whales harvested from the 1970's to the present;
- Two whale-feeding areas are traditionally recognized, one to the east in the Demarcation Point/Icy Reef area and the other near Arey Island must west of Kaktovik;
- Whales can occur near Kaktovik in July and August, although they are more common in Canadian water at this time; and
- Kaktovik's main hunting period for bowheads is in September, but whales can remain near Kaktovik as late as mid-October (Richardson and Thomson, 2002).

IV.C.11.b(1)(b)2) Seals, Beluga Whales, and Polar Bears

The effects from exploration only are expected to be less than those from development and production, with only brief disturbances of small numbers of seals, polar bears, and beluga whales from air and vessel traffic, with recovery from any disturbance event occurring within less than 1 day. For Beaufort Sea oil and gas exploration and development, noise and disturbance and habitat alterations from drill-platform installation, pipeline laying, and other construction could have some adverse effects on seals, polar bears, and beluga whales found in the lease-sale area. Scientific and local Native knowledge of the behavior of nonendangered marine mammals and the nature of noise associated with offshore oil and gas activities suggest that intense noise causes startle, annoyance, and flight responses of seals, polar bears, and beluga whales. Helicopter trips and supply-boat traffic to and from the one to two exploration-drilling platforms and the three to five production platforms could disturb some hauled out ringed, bearded, and spotted seals, causing them to panic and charge into the water, resulting perhaps in the injury, death, or abandonment of small numbers of seal pups. Because nursing seals and pups are widely distributed along the ice front, aircraft moving to and from drill platforms are likely to temporarily disturb only a small portion of these seal populations. Aircraft disturbance of seals and polar bears is likely to cause short-term displacement (a few minutes to less than a few days) of small numbers of these animals (less than a few hundred) within about 1 kilometer of the air-traffic route. Vessel traffic (7-14 trips per year) associated with exploration-drilling units, production platforms, and seismic vessels operating during the open-water season temporarily could displace or interfere with marine mammal migration and change local distribution for a few hours to a few days. Such short-duration and local displacement (within 1-3 kilometers [0.62-1.9 miles] is expected to have a short-term (less than a few days') effect on the distribution of seals, polar bears, and beluga whales. The installation of eight production platforms and the laying of 115 miles of offshore pipelines within a few square kilometers of benthic habitat likely would have a short-term and local effect on these marine mammals.

In the unlikely event of a large oil spill occurring and contacting and extensively oiling coastal habitats, the presence of cleanup personnel, boats, and aircraft operating in the cleanup area is expected to displace seals, polar bears, and other marine mammals in the oiled areas and to contribute to increased stress and reduced pup survival of ringed seals, if operations occur during the spring. This effect is expected to persist for perhaps 1 or 2 years and to affect seals, polar bears, and other marine mammals within about 1.6 kilometers (1 mile) of the activity.

IV.C.11.b(1)(b)3) Caribou and Other Terrestrial Mammals

Exploration is expected to have very brief (few minutes to less than 1 hour) disturbance effects on caribou, muskoxen, grizzly bears, and arctic foxes, with recovery occurring within a day or less and to have no effect on these populations.

Under development, the primary source of disturbance to caribou, muskoxen, grizzly bears, and arctic foxes is air and ice-road traffic that would be associated with onshore construction and transportation of oil from offshore leases. Disturbance of caribou, muskoxen, grizzly bears, and arctic foxes along onshore pipelines to the Trans-Alaska Pipeline System would be most intense during the construction period (perhaps 6 months), when ice-road traffic is highest, but would subside after construction is complete. Caribou and muskoxen are likely to successfully cross the pipeline corridor within a short period of time (a few minutes to a few hours) during breaks in the traffic flow, even during high traffic periods, with little or no restriction in movements. Because oil transportation for development of Federal offshore leases east of the Canning River is expected to be located offshore of the Arctic National Wildlife Refuge, caribou of the Porcupine Caribou Herd that calve on the Refuge are not likely to be affected by the development activity.

The effects of Beaufort Sea oil exploration and development on caribou, muskoxen, grizzly bears, and arctic foxes are expected to include local displacement within about 1-2 kilometers (0.62-1.2 miles) along onshore pipelines, with local effects persisting during construction activities. Brief disturbances (a few minutes to a few days) of groups of caribou and muskoxen could occur along the pipeline corridor during periods of high ice-road and air traffic, but these disturbances are not expected to affect overall population movements and distributions.

In the unlikely event of a large oil spill occurring and contacting and extensively oiling coastal habitats containing herds or bands of caribou during the insect season, the presence of cleanup personnel, boats, and aircraft operating in the area of cleanup activities is expected to cause displacement of some caribou in the oiled areas and contribute temporarily to seasonal stress on some animals. This effect likely would occur during cleanup operations (perhaps 1 or 2 seasons) but is not expected to significantly affect caribou herd movements or foraging activities of the populations. Cleaning up a large oil spill also would disturb some muskoxen, grizzly bears, and arctic foxes. An oil spill could result in the loss of small numbers of grizzly bears and arctic foxes through ingestion of contaminated prey or carrion. However, such losses are not expected to be significant to their populations on the Arctic Slope.

In 1979, Nuiqsut resident Nannie Woods talked about fish and caribou being less abundant at the Sagavanirktok River since the development at Prudhoe Bay. She explained that the river's tributaries also did not have as many fish, and that fewer caribou were there now than there used to be in the summer (Woods, 1979, as cited in USDOI, Bureau of Land Management, 1979a).

At the MMS Information Update Meeting held March 29, 2000, in Barrow, the Alaska Department of Fish and Game made a presentation on a draft study of subsistence economics and oil development in Nuiqsut and Kaktovik, which affirmed a strong connection to anthropogenic effects as the cause for the displacement of subsistence hunters from traditional caribou-hunting areas near Nuiqsut during the 1993 and 1994 harvest seasons (Pedersen et al., In prep.).

Mayor Leonard Lampe said at an MMS Liberty Project Information Update Meeting in November 1999 that they do not see as many calving caribou as they did before. The Tarn Project well has changed their south/north migration, and the Alpine development may affect their east/west migration. Caribou now have to cross three pipelines. At the same meeting, Elder Ruth Nukapigak stated she believed contamination is happening to the caribou from air pollution. They smell the smoke from Alpine and scatter.

IV.C.11.b(1)(b)4) Fish

Noise, disturbance, and discharges from dredging, gravel mining, island construction, island reshaping, pipeline trenching, and abandonment are expected to have no measurable effect on fish populations, including incidental anadromous species. While a few fish could be harmed or killed, most in the immediate area would avoid these activities and would be otherwise unaffected. Effects on most overwintering fish are expected to be short term and sublethal, with no measurable effects on overwintering fish populations.

Because of the low density of fish in the Beaufort Sea, and the low probability that they would be harmed by cleanup equipment, oil-spill-cleanup activities in open water or in broken ice are not expected to adversely affect fish populations. Reducing the amount of oil in the marine environment is expected to have a beneficial effect by reducing the possibility of hydrocarbons contacting fish and their food resources. The extent of that benefit would depend on the actual reduction in the amount of oil contacting fish and their food resources, as compared to not reducing the amount of contact.

Subsistence hunter Isaac Nukapigak, from Nuiqsut, observed that cisco are not spawning out near the Colville Delta anymore, explaining that oil activities in State waters there are having an effect (Nukapigak, 1995, as cited in USDOI, MMS, 1995d). Nuiqsut resident Joan Taleak maintained reservations about local traffic by industrial vessels during her 1983 testimony for a proposed OCS sand and gravel lease sale. She was concerned about the barges hauling gravel conflicting with fishing that had been her way of life since childhood. She recounted her worry that there would be no more whitefish if the sale activities occurred (Taleak, 1983, as cited in USDOI, MMS, 1983a).

Native concern about the effects of development on fish stocks has been evident since the Endicott Project. In 1984, Thomas Napageak, Nuiqsut whaling captain and Chairman of the Alaska Eskimo Whaling Commission, said: “The causeway sticking out into the ocean will change currents along the coast. Furthermore, it will change the migration route of the fish we depend on” (Napageak, as cited in U.S. Army Corps of Engineers, 1984). Complaints about reduced size of the fish harvested persist in Nuiqsut, and fish are an important subsistence resource, accounting for 33% of the community’s total subsistence harvest in 1993 (Pedersen, 1996) and 25% in 1995 (Brower and Opie, 1997). Nuiqsut fish harvesters have noted that Arctic cisco have decreased, coinciding with the operation of Endicott’s water-treatment plant (Dames and Moore, 1996a). Wilber Ahtuangaruak, from Nuiqsut, maintained almost 2 decades ago that there “aren’t as many whitefish since the oil companies started drilling at Flaxman Island” (Ahtuangaruak, 1979, as cited in USDOI, Bureau of Land Management, 1979a); Joseph Akpik, from Nuiqsut, asserts that offshore exploration would affect the cisco population (Akpik, 1995, as cited in USDOI, MMS, 1995a).

At an MMS Liberty Project Information Update Meeting in November 1999 in Nuiqsut, Elders Lloyd Ipalook, Alice Ipalook, and Ruth Nukapigak said that fish stocks were very low. Alice Ipalook and Ruth Nukapigak both noted that they had seen a decrease in whitefish since the work at Kalubik, and that there used to be 100-200 fish caught per day versus 6-9 per day now.

IV.C.11.b(1)(b)5) Birds

Disturbance from all sources, especially helicopter traffic, is expected to result primarily in short-term displacements of birds from the local areas where disturbance events are occurring; disturbance of local nesting birds probably would have little effect on Arctic Slope bird populations as a whole. Little direct mortality is expected, but losses of eggs and young to predators when adults are displaced is likely to occur. Routinely disturbed adults may experience lowered fitness with resulting declines in survival and productivity over the life of the field. Recovery of losses to bird populations adversely affected by discharges, all sources of disturbance, and habitat alteration is expected to occur within a few generations. The overall potential effect of disturbance and habitat alteration on marine and coastal birds would be the short-term displacement of nesting, feeding, molting, and staging birds and a decline in fitness, requiring 1 generation (about 2-4 years) for population recovery.

The presence of large numbers of workers, boats, and aircraft following a spill is expected to displace eiders foraging in affected offshore or nearshore and coastal habitats during open-water periods for one to several seasons. Disturbance during the initial season, possibly lasting 6 months, is expected to be frequent. Cleanup in coastal areas late in the breeding season may disturb broodrearing, juvenile, or staging birds. However, staging or migrating flocks of most species generally are dispersed and, thus, would not necessarily occur in the vicinity of cleanup activity; as a result, relatively few flocks are likely to be displaced from favored habitats and expend energy stores accumulated for migration. However, large flocks of long-tailed ducks molting in lagoons, and common eiders occupying barrier islands or lagoons are particularly susceptible if they are nesting, broodrearing, or flightless. Although little direct mortality from cleanup activity is expected, predators may take some eggs or young while females are displaced off their nests if located near a site of operation. Survival and fitness of individuals may be affected to some extent, but this infrequent disturbance is not expected to result in significant population losses.

Kaktovik resident Mike Edwards stated in public testimony that he thought noise would harm the waterfowl, an important springtime source of food (Edwards, 1979, as cited in USDOI, Bureau of Land Management, 1979b).

IV.C.11.b(1)(c) Additional Native Concerns About Noise and Disturbance

IV.C.11.b(1)(c)1) Access

Local residents have voiced concerns about access restrictions. Sarah Kunaknana, talking about local subsistence hunters, stated that others say they do not hunt near Prudhoe Bay anymore because of oil development (Kunaknana, as cited in Shapiro, Metzner, and Toovak, 1979). Billy Oyagak from Nuiqsut said supply ships, choppers, and drilling interfered with whale hunting, making it difficult to find any animals. That year, the hunt required 5 weeks to complete (Oyagak, 1986, as cited in USDOI, MMS, 1986a). Nelson Ahvakana, from Nuiqsut, was concerned that areas that are supposed to be left open for subsistence hunting effectively will be closed because of increased security at the new drill sites, and access to subsistence resources will be restricted (Ahvakana, 1990, as cited in USDOI, MMS, 1990d).

This concern takes on even more substance as the Northstar Project, development at the Alpine field, and leasing in the National Petroleum Reserve-Alaska become realities. During a 1996 meeting on the Northstar Project in Nuiqsut, two Nuiqsut men described being denied access to fishing and hunting areas around Prudhoe operations even though they have traditional rights to be there. They do not want new projects to restrict or deny access (Dames and Moore, 1996b). A whaler voiced concern that BPXA or the Federal Government would block the whalers from taking their traditional whaling route to Cross Island if a production facility were developed at Liberty Island. They prefer to travel within the barrier islands, because they are more protected from the sea (Dames and Moore, 1996b).

Barrow resident Charles Brower stated in 1986 that an onshore pipeline could interfere with subsistence access; additional hunting restrictions would occur, requiring a permit (Brower, 1986, as cited in USDOI, MMS, 1986c).

IV.C.11.b(1)(c)2) Construction

Native residents expressed concern at a Northstar public meeting about the possibility of steel and concrete fatigue over the 15-year project life of the Northstar Project (Dames and Moore, 1996b).

IV.C.11.b(1)(c)3) Dredging

Speaking at public hearings in Nuiqsut, Edward Nukapigak, Sr., declared: "If they want gravel, they should not get it from the paths of the animals that we eat" (Nukapigak, 1983, as cited in USDOI, MMS, 1983a). At village meetings in August 1996 for the Northstar Project, Natives stated that currents can change the bottom contours, potentially affecting the buried pipeline, particularly from river overflow (Dames and Moore, 1996a). Nuiqsut whaling captains believe that Seal Island, as planned for Northstar, needs more protection from natural elements to be considered safe by the community (Dames and Moore, 1996b).

Testifying at public hearings for a proposed offshore sand and gravel lease, Othniel Oomittuk from Barrow explained that the "water from the dredge operation would also [dis]place the bowhead from their normal fall migration pattern. It drives the whales out, as whalers can't get to them with their small whaling boats" (Oomittuk, 1983, as cited in USDOI, MMS, 1983a).

IV.C.11.b(2) Large Oil Spills

IV.C.11.b(2)(a) General Effects from Oil Spills

General effects from oil exploration and development could be expected from potential oil spills and tainting and the cleanup disturbance that could occur after such a spill event. An oil spill affecting any part of the migration route of the bowhead whale could taint a resource that is culturally pivotal to the subsistence lifestyle. Even if whales were available for the spring and fall hunts, tainting concerns could leave bowheads less desirable and alter or stop the subsistence hunt. Communities unaffected by a potential spill would share bowhead whale products with impacted villages, and the harvesting, sharing, and processing of other resources should continue. Concerns about tainting would apply also to polar bears and seals and, in the unlikely event of a large oil spill, it could cause potential short-term but serious adverse effects to some bird populations. A potential loss of a small number of polar bears would reduce their local availability to subsistence users. Oil-spill-cleanup activities could produce additional effects on subsistence activities, potentially causing displacement of subsistence resources and subsistence hunters.

Although a spill could originate within the Beaufort Sea multiple-sale area, its indirect impacts might be felt by communities remote from the sale area and far removed from the spill. Essentially, concerns about subsistence harvests and subsistence food consumption would be shared by all Inupiat and Yup'ik Eskimo communities in the Chukchi and Bering seas adjacent to the migratory corridor used by whales and other migrating species. Tainting concerns in these communities about resources initially and secondarily oiled could seriously curtail traditional practices for harvesting, sharing, and processing important subsistence species, because all communities would share concerns over the safety of subsistence foods in general and whale food products and the health of the whale stock, in particular.

IV.C.11.b(2)(b) Specific Effects on Subsistence Resources

IV.C.11.b(2)(b)1) Bowhead Whales

In the unlikely event of a large oil spill, the probability of oil contacting whales is likely to be considerably less than the probability of oil contacting bowhead habitat. If a spill occurred and contacted bowhead habitat during the fall migration, it is likely that some whales would be contacted by oil. It is unknown what effects an oil spill would have on bowhead whales, but some conclusions can be drawn from studies that have looked at the effects of an oil spill on other types of whales. It is likely that some whales would experience temporary, nonlethal effects, including one or more of the following symptoms: (1) oiling of their skin, causing irritation; (2) inhaling hydrocarbon vapors; (3) ingesting oil-contaminated prey; (4) fouling of their baleen; (5) losing their food source; and (6) temporary displacement from some feeding areas.

Some whales could die as a result of contact with spilled oil. Geraci (1990) reviewed a number of studies on the physiologic and toxic effects of oil on whales and concluded there was no evidence that oil contamination had been responsible for the death of a cetacean. Nevertheless, the effects of oil exposure to the bowhead whale population are uncertain, speculative, and controversial. The effects would depend on how many whales contacted oil, the duration of contact, and the age and degree of weathering of the spilled oil. The number of whales contacting spilled oil would depend on the location, size, timing, and duration of the spill and the whales' ability or inclination to avoid contact. If oil got into leads or ice-free areas frequented by migrating bowheads, a large portion of the population could be exposed to spilled oil. Prolonged exposure to freshly spilled oil could kill some whales, but the number likely would be small. Whales exposed to spilled oil are likely to experience temporary, nonlethal effects, although prolonged exposure to freshly spilled oil could kill some whales. Traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term, if there are concerns over the tainting of bowhead whales or their feeding areas from an oil spill.

Barrow elder Thomas Brower, Sr., observed an oil spill from a U.S. Navy vessel in the Plover Islands east of Barrow in 1944 where about 25,000 gallons were spilled. According to Brower: "for four (4) years after that oil spill, the whales made a wide detour out to sea from these islands. Those Native families could no longer hunt whales during these years at that location" (Brower, as cited in North Slope Borough, Commission on History and Culture, 1980).

Although this spill event reveals that species can experience recovery from an oil spill in the Arctic after 4 years without cleanup, the event is remembered more importantly as a time of devastation and deprivation by those who directly witnessed the effects of the spill or those who were told of the event by witnesses. Not only were whales absent for 4 years following the spill, but other resources were absent or occurred in reduced numbers. The people of Barrow who remember the spill consider it evidence that even a relatively small oil spill in a defined area can have lasting effects on subsistence resources and harvests.

IV.C.11b(2)(b)2) Seals, Beluga Whales, and Polar Bears

The effects from activities associated with Beaufort Sea oil and gas exploration and development are estimated to include the loss due to an oil spill (0.11% chance) of small numbers of seals (perhaps 300 ringed, probably fewer than 10-20 spotted, and 30-50 bearded seals; fewer than 100 walruses; perhaps 5-30 polar bears; and fewer than 10 beluga and gray whales, with populations recovering (the replacement of individuals killed as a consequence of exploration and development) within about 1 year.

Thomas Brower, Sr. stated that:

> In the cold, Arctic water, the oil formed a mass several inches thick on top of the water. Both sides of the barrier islands in that area—the Plover Islands—became covered with oil. That first year, I saw a solid mass of oil six (6) to ten (10) inches thick surrounding the islands. On the seaward side of the islands, a mass of thick oil extended out sixty (60) feet from the islands, and the oil slick went much further offshore than that. I observed how seals and birds who swam in the water would be blinded and suffocated by contact with the oil. It took approximately four (4) years for the oil to finally disappear (Brower as cited in North Slope Borough, Commission on History and Culture, 1980).

Again, it should be noted that some species' recovery was seen after 4 years.

IV.C.11.b(2)(b)3) Caribou and Terrestrial Mammals

A possible oil spill (1,500 or 4,600 barrels) could cause the loss of perhaps a few hundred caribou. The numbers of muskoxen, grizzly bears, and arctic foxes affected are expected to be fewer than 10 individuals per species, based on their scattered distribution on the North Slope.

Coastline habitats from Dease Inlet, Cape Simpson east to the Atigaru Point-Kogru River area (Land Segments 26, 28-33, and 47), and coastline habitats in the Kaktovik area (land segment 47) have the highest risks of spill contact: from 15% up to 21% from either LA1-LA18 or P1-P13, assuming spills occur during the summer season and contact the coastline within 30 days (Table A.2-27). An estimated 29-49 kilometers of coastline could be oiled by the 1,500- or 4,600-barrel spill. Some caribou from the Teshekpuk Lake, Western Arctic, Central Arctic, or Porcupine Caribou herds could contact oil in these areas, as they move into these areas to escape insects. Even in a severe situation, perhaps 10 to a few hundred animals from one of these herds could get oil on their coats and die from toxic hydrocarbon inhalation and absorption. This loss probably would be small for any of these caribou herds and would be replaced within about 1 year.

For the most part, the effect of onshore pipeline spills would be very local and would contaminate tundra in the immediate vicinity of the pipeline; these spills would not be expected to significantly contaminate or alter caribou and muskox range within pipeline corridors.

In the unlikely event that a large oil spill occurred in the Beaufort Sea, it is expected to result in the loss of no more than perhaps a few hundred caribou, and probably fewer than 10 individual muskoxen, grizzly bears, and arctic foxes, with recovery expected within about 1 year.

IV.C.11.b(2)(b)(4) Fish

Likely effects on arctic fishes, including incidental anadromous species, from a large oil or diesel fuel spill would depend primarily on the season and location of the spill, the lifestage of the fish (adult, juvenile, larval, or egg), and the duration of the oil contact. Because of their very low numbers in the spill area, no measurable effects are expected on fish in winter. Effects would be more likely to occur from an offshore oil spill moving into nearshore waters during summer, where fish concentrate to feed and migrate. If an offshore spill did occur and contacted the nearshore area, some marine and migratory fish could be harmed or killed. However, it would not be expected to have a measurable effect on fish populations, and recovery would be expected within 5-7 years. In general, the effects of fuel spills on fish are expected to be less than those of crude-oil spills.

If a pipeline spill occurred onshore and contacted a small waterbody supporting fish (for example, ninespine stickleback, arctic grayling, and Dolly Varden char) and had restricted water exchange, it would be expected to kill or harm most of the fish within the affected area. Recovery would be expected in 5-7 years. However, because of the small amount of oil or diesel fuel likely to enter freshwater habitat, the low diversity and abundance of fish in most of the onshore area, and the unlikelihood of spills blocking fish migrations or occurring in overwintering areas or small waterbodies that contain many fish or fish eggs, an onshore spill of this kind is not expected to have a measurable effect on fish populations on the Arctic Coastal Plain.

IV.C.11.b(2)(b)5) Birds

The loss of several thousand long-tailed ducks on the regional population is difficult to determine but probably would not have a significant long-term adverse effect on the regional population because recruitment could replace the loss within several generations unless the population is in fact declining significantly, in which case we would not expect recovery. The recovery period required for a loss from the suite of species typically occupying the nearshore and offshore Beaufort Sea of up to about 10,000 individuals is difficult to estimate, because species will recover at different rates. Some species with low reproductive rates or population levels (for example, loons, black guillemot) may not suffer high mortality as a result of an oil spill, because they are not abundant in most of the proposed the sale area and do not occur in large feeding flocks, although any losses would recover slowly due to relatively low reproductive rates.

The relatively small losses of most species, other than the long-tailed duck, likely to result from an oil or fuel spill in the Beaufort Sea may be difficult to separate from natural variation in population numbers. This has been found for other waterbird populations under similar circumstances. Regardless of the factors involved in causing mortality, complete recovery of Arctic Coastal Plain populations of some species (for example, eiders) from even small losses in the proposed lease area would not occur until their populations are stable or increasing, as they apparently have been declining since 1992. This probably is due to these species' low reproductive rates. Recruitment of individuals into the population under such circumstances is likely to be low and losses from spill mortality, intensified by low productivity or lowered survival of any age groups, is expected to increase the length of time required for recovery to former population levels. Because the amount of information on rates of productivity, survival, and recruitment currently available makes it difficult to determine the recovery rate of either local or entire coastal plain populations from incidents causing mortality, the long-term effect of oil-spill mortality is uncertain. Also, different rates of decline could be ongoing in various parts of the population but undetected between individual survey years by current survey methodology. Currently, eider numbers on the coastal plain generally appear to be stable, or increasing or declining at a nonsignificant rate. When the population is declining, the rate of recovery from any substantial oil spill or other mortality associated with oil and gas development is likely to be negatively affected. In addition, any recovery from mortality associated with the first sale, which is likely to involve the largest numbers of individuals of the three due to the presence of two drill sites in the relatively small Near Zone where bird activity is concentrated, is expected to be delayed by any mortality resulting from the subsequent two sales. With any substantial mortality, the potential exists for a significant adverse effect on these populations. Losses from oil spills likely would include the loss of several thousand birds due to oil contamination, with population recovery expected within a few generations.

IV.C.11.b(2)(c) How Oil-Spill Contact May Affect Subsistence-Harvest Patterns

No oil spills are assumed to occur during exploration activities. For the development and production phase, a 1,500-barrel spill from a platform, or a 4,600-barrel spill from a pipeline are assumed in this EIS. The probabilities of either spill contacting specific environmental resource areas would be the same. The 1,500-barrel spill would cover a smaller area (181 square kilometers) than the 4,600-barrel spill (320 square kilometers) after 30 days. Only the 4,600-barrel spill is discussed below, as it represents the highest range of potential contact and impact from an oil spill.

A 4,600-barrel spill could contact environmental resource areas where important subsistence resources are present. The following discussion presents conditional and combined probabilities estimated by the Oil-Spill-Risk Analysis model (expressed as a percent chance) of a spill contacting subsistence-resource areas. Conditional probabilities are based on the assumption that a spill has occurred and makes contact. Combined probabilities, on the other hand, factor in the chance of the spill occurring. Oil-spill contact in winter could affect polar bear hunting and sealing. During the open-water season, a spill could affect bird hunting, sealing, and whaling, as well as netting of fish in the ocean.

For conditional probabilities, the oil-spill model estimates a 7-74% chance of a 4,600-barrel oil spill starting at LA1-LA8 contacting important Barrow (ERA's 2 (Point Barrow) and 42 (Bowhead Whaling Area) within 30 days during the summer, and a 5-75% chance of contact from LA1-LA10 over a 360-day period. There is a 9-58% chance of contact from P1-P9 within 30 days and a 7-58% chance of contact in 360 days. Land Segments 25 (Elson Lagoon), 26 (Dease Inlet), 27 (Kurgorak Bay), 28 (Cape Simpson), and 29 (Smith Bay) have a 5-17% chance of contact from a summer spill originating at LA1-LA6 for 30 days and 5-18% chance of contact for 360 days. From a spill originating at PA1, PA2, or PA8, there is a 5-21% chance of contact for both 30 days and 360 days.

Winter-contact percentages generally are less. For a 30-day period, they range from 0-9% starting at LA8-LA9, and 5-16% over a 360-day period from LA1-LA13. For 30 days, there is a 0-6% chance of contact from P1 and P8, and a 5-20% chance of contact from P1-P10 for 360 days (see Tables A.2-21, A.2-24, A.2-45, and A.2-48). Only Land Segment 28 has a chance of contact within 30 days—5% from a spill origination at P8.

The oil-spill model estimates a 6-53% chance of a 4,600-barrel oil spill starting at LA6-LA15 contacting important Nuiqsut ERA's 3 (Thetis, Jones, and Spy islands), 4 (Cottle and Return islands), 5 (Reindeer Island), 6 (Cross Island Vicinity), 10 (Tigvariak Island), 12 (Flaxman Island/Brownlow Point), 43 (Cross Island Whaling Area), and 69 (Harrison Bay/Colville Delta) within 30 days during the summer and a 5-54% chance of contact from LA5-LA15 over a 360-day period. There is a 5-32% chance of contact from P1-P6 and P10-P12 within 30 days and a 5-33% chance of contact in 360 days from P2-P6 and P9-P13. Land Segments 35 (Colville River Delta), 36 (Oliktok Point), 37 (Milne Point), and 38 (Kuparuk River) have a 5-7% chance of contact from a summer spill originating at LA8, LA10, or LA12 for 30 days and a 5-8% chance of contact for 360 days from LA7-LA13. From a spill originating at P4, P10, or P11, there is a 5-15% chance of contact for 30 days and from P3-P5 and P10-P12, there is a 5-16% chance of contact within 360 days. Land segments from the Colville River Delta to Bullen Point-Tigvariak Island include areas historically used by Nuiqsut subsistence hunters to harvest caribou, waterfowl, marine fish, polar bears, and small furbearers. This is not an area of high subsistence use at the present time. More recently, hunting appears to take place nearer to the community and onshore areas of primary importance on the Colville River Delta.

Winter-contact percentages for a 30-day period range from 5-15% starting at LA12, and 5-33% over a 360-day period from LA10-LA15. For 30 days, there is a 6-14% chance of contact from P10-P12 and a 5-34%

chance of contact from P3-P6 and P9-P13 for 360 days (see Tables A.2-21, A.2-24, A.2-45, and A.2-48). Only LS 36 has a chance of contact within 30 days—6% from a spill origination at P10.

Environmental resource areas for Kaktovik contain crucial harvest areas for caribou, waterfowl, fish, and seals. The oil-spill model estimates a 6-42% chance of a 4,600-barrel oil spill starting at LA14-LA18 contacting important Kaktovik ERA's 12 (Flaxman Island/Brownlow Point), 16 (Jago Spit Area), and 44 (Kaktovik Whaling Area) within 30 days during the summer, and a 11-34% chance of contact from LA4-LA18 over a 360-day period. There is an 8-48% chance of contact from P6, P7, or P13 within 30 days and a 5-39% chance of contact in 360 days from P6, P7, P12, or P13. Land Segments 42 (Point Hopson), 43 (Brownlow Point), 46 (Arey Island/Barter Island), 47 (Kaktovik), 48 (Griffin Point), 49 (Beaufort Lagoon), and 50 (Icy Reef) have a 5-12% chance of contact from a summer spill originating at LA16, LA17, or LA18 for 30 days and a 5-13% chance of contact for 360 days from LA14-LA18. From a spill originating at P7 or P13, there is a 5-16% chance of contact for 30 days and from P6, P7, P12, or P13, there is a 5-17% chance of contact within 360 days.

Winter-contact percentages for a 30-day period range from no chance of contact from any launch area to any environmental resource area to a 5-12% chance of contact over 360 days from LA16-LA18. For 30 days, there is no chance of contact from any P segment to any environmental resource area and a 10% chance of contact from P7 for 360 days (See Tables A.2-21, A.2-24, A.2-45, and A.2-48). No launch areas have a chance of contact within 30 and 360 days.

Combined probabilities express the percent chance of one or more oil spills greater than or equal to 1,000 barrels occurring and contacting a certain environmental resource area over the production life of the Beaufort Sea multiple-sale area. For combined probabilities, the oil-spill model estimates a 0.5-1% chance that an oil spill would occur from a platform or a pipeline (LA1-LA18 or P1-P13, respectively) and contact subsistence specific ERA's 2, 3, 42, 69, 74, 83, and LS 27 within 360 days (Table A.2-56).

The potential for bowhead whales to be contacted directly from an oil spill from the Beaufort Sea multiple sales is relatively small, but the potential chance of contact to whale habitat, whale-migration corridors, and subsistence-whaling areas is considerably greater. Onshore areas and terrestrial subsistence resources, in general, seem to have a lower potential for oil-spill contact.

IV.C.11.b(2)(d) Effects of Cleanup Activities on Subsistence Resources and Harvests

Disturbance to bowhead whales, seals, polar bears, caribou, fishes, and birds would increase from oil-spill-cleanup activities. Offshore, skimmers, workboats, barges, aircraft overflights, and in situ burning during cleanup could cause whales to temporarily alter their swimming direction. Such displacement would cause some animals, including seals in ice-covered or broken-ice conditions, to avoid areas where they normally are harvested or to become more wary and difficult to harvest. People and boats offshore and people, support vehicles, and heavy equipment onshore, as well as the intentional hazing and capture of animals would disturb coastal resource habitat, displace subsistence species, alter or reduce subsistence-hunter access to these species, and alter or extend the normal subsistence hunt. Deflection of resources, resulting from the combination of a large oil spill and spill-response activities, would persist beyond the timeframe on a single season, perhaps lasting several years. The result would be a major effect on subsistence harvests and subsistence users, who would suffer impacts on their nutritional and cultural well-being.

Identified spill-cleanup strategies potentially would reduce the amount of spilled oil in the environment and tend to mitigate spill-contamination effects. In the case of a winter spill, when few important subsistence resources would be present, cleanup is likely to be fairly effective in dealing with a spill before migrating whales and other species return to the area during breakup and the open-water season. Ringed seals are common during the winter, but they are not harvested by local subsistence hunters during this period. Subsistence hunting also would be impacted by any spill that required the local knowledge, the experience, and the vessels of local whaling captains. This diverting of effort and equipment to oil-spill cleanup would adversely impact the subsistence whale hunt. Far from providing mitigation, oil-spill-cleanup activities more likely should be viewed as an additional impact, potentially causing displacement of the subsistence hunt, subsistence resources, and subsistence hunters (see Impact Assessment, Inc., 1998).

IV.C.11.b(2)(e) Native Views on Oil Spills

IV.C.11.b(2)(e)1) Barrow's Views on Oil Spills

Barrow is very concerned about oil spills, particularly oil-spill response. In 1983, Percy Nusunginya from Barrow related:

> This summer there was supposed to be a demonstration on oil spill response but the weather did not cooperate in the Arctic, so we will expect the industry to have an oil spill on a calm day (Nusunginya, 1983, as cited in USDOI, MMS, 1983b).

Don Long from Barrow stated in 1990:

> Any disruption, whether it be oil spill or noise, would only disturb the normal migration [of bowhead whales], and a frightened or a tense whale is next to impossible to hunt" (Long, 1990, as cited in USDOI, MMS, 1990b).

Eugene Brower from Barrow expressed the general concern that spill-cleanup procedures under ice do not exist (Brower, 1990, as cited in USDOI, MMS, 1990b) and, similarly, in 1995 hearings in Barrow, Edward Hopson asserted that technology is not in place to deal with spills in the Arctic Ocean (Hopson, 1995, as cited in USDOI, MMS, 1995b). Marie Adams, also from Barrow, observed that an oil spill in the "fragile ecosystem" of the Arctic could devastate the bowhead whale because these animals migrate through "narrow open-lead systems," which could be the preferred path of an oil spill (Adams, 1990, as cited in USDOI, MMS, 1990b).

Having been a whaler since 1916, Thomas P. Brower, Sr., from Barrow, in a 1978 interview, gave an extraordinary account of an oil spill in the Arctic and its effects:

> I have also seen how sensitive the whales are to water pollution. The commercial whaling ships would always avoid pumping their bilge tanks in the whaling areas. I observed that if some bilge water had to go over the side, it would always be first strained and cleaned before dumping. In 1944, I saw the effects of an oil spill on Arctic wildlife, including the bowhead. I had been asked to be on the flagship [the *U.S.S. Spica*] of a Navy convoy moving along the Beaufort Sea coast. While I was on the flagship, I saw twenty (20) other ships including several Navy oil tankers. In August 1944 one of the cargo ("Liberty") ships [the S.S. *Jonathan Harrington*] ran aground on a sandbar off Doctor Island in Elson Lagoon, southeast of Utqiagvik [Barrow]. They needed to lighten the ship to get free. To my disgust, instead of bringing up a tanker to transfer the cargo, they simply dumped the oil into the sea. About 25,000 gallons of oil were deliberately spilled into the Beaufort Sea in this operation. In the cold, Arctic water, the oil formed a mass several inches thick on top of the water. Both sides of the barrier islands in that area--the Plover Islands--became covered with oil. That first year, I saw a solid mass of oil six (6) to ten (10) inches thick surrounding the islands. On the seaward side of the islands, a mass of thick oil extended out sixty (60) feet from the islands, and the oil slick went much further offshore than that. I observed how seals and birds who swam in the water would be blinded and suffocated by contact with the oil. It took approximately four (4) years for the oil to finally disappear. I have observed that the bowhead whale normally migrates close to these islands in the fall migration. Native families living in the area of Utqiagvik and Elson Lagoon were accustomed to catching small whales in the fall for the winter food supply. But I observed that for four (4) years after that oil spill, the whales made a wide detour out to sea from these islands. Those native families could no longer hunt whales during these years at that location...If there were a major blowout, all the Inupiat could be faced with the end of their marine hunting, just as those families near Elson lagoon suffered in 1944 through 1948. (North Slope Borough, Commission on History and Culture, 1980).

IV.C.11.b(2)(e)2) Nuiqsut's Views on Oil Spills

Ruth Nukapigak from Nuiqsut spoke in 1983 about the effects she had seen from drilling nearby. She had discovered that fish are afraid of suds or foam and had seen oil in the water. She had heard that when there is an oil spill, it's cleaned up with suds or foam. For those living in Nuiqsut, she believes their food is really going to change from what the oil companies are going to be doing (Nukapigak, 1983, as cited in USDOI, MMS, 1983a). Maggie Kovalsky, also from Nuiqsut, expressed the same fear about effects on

Nuiqsut's subsistence foods. She explained that if a spill ever happened, she thinks it would harm a lot of the food they depend on, such as fish and bowhead whale and duck (Kovalsky, 1984). Nuiqsut elder Sarah Kunaknana was worried that an oil spill could occur and damage the habitat of the bowhead whales and other sea mammals (Kunaknana, 1990, as cited in USDOI, MMS, 1990d).

In a Statewide survey conducted from 1992-1994 by the Alaska Department of Fish and Game, Division of Subsistence, 80% of the respondents in Nuiqsut believed that industry could not contain and clean up a large oil spill. A similar question about containing and cleaning up a small oil spill got negative responses from 60% of the people in Nuiqsut (State of Alaska, Dept. of Fish and Game, 1995a). Ice forces can be unpredictable, and Frank Long, Jr., a whaler from Nuiqsut, expressed local concern that an oil spill could be caused by ice scraping a pipeline or drill pipe, and the resulting spill would damage the entire food chain (Long, 1995, as cited in USDOI, MMS, 1995a). In 1996, people in Nuiqsut reiterated their belief that technology does not exist to clean up an oil spill under the ice; they believe it is a matter of *when* a spill will occur, not *if* it will occur. They want assurance against disaster and impact funds set aside for them in case this happens (Dames and Moore, 1996a).

Issues about using local expertise and people are prevalent in Nuiqsut. Leonard Lampe, Nuiqsut's former mayor, reported:

> As a member of the village oil spill-response team, we were not allowed to go out onto the ice even for drills under certain very dangerous conditions. So what if a spill occurs under those conditions? There will be no way to clean it up (Lampe, 1995, as cited in USDOI, MMS, 1995a).

IV.C.11.b(2)(e)3) Kaktovik's Views on Oil Spills

Over many years, Kaktovik has voiced its concerns over ice hazards to oil rigs and possible oil spills. In 1979, Philip Tiklul from Kaktovik observed that the ice movements are strong enough to damage an oil rig and cause a spill (Tiklul, 1979, as cited in USDOI, BLM, 1979b). Kaktovik subsistence hunter Jonas Ningeok explained that the weather is very unpredictable. Sudden snowstorms can be dangerous. Pressure ridges may form in the ice, damage the oil rig, and cause a spill (USDOI, MMS, 1990c). At the same hearing in 1990, Nolan Soloman expressed a similar concern when he stated that oil rigs may fail under the strain of the ice (Soloman, 1990, as cited in USDOI, MMS, 1990c). Recently, Fenton Rexford, President of Kaktovik Inupiat Corporation and a subsistence hunter, declared that the:

> Inupiat here in Kaktovik are adamantly against offshore production until there is proven technology of a cleanup of an oil spill under ice-infested waters. It wasn't quite proven yet on onshore even. (Rexford, 1996, as cited in Dames and Moore, 1996c).

Kaktovik residents often have spoken about the threat from oil spills to subsistence food resources. Herman Rexford voiced concern in 1982 that an oil spill would damage the food the whales live on (Rexford, 1982, as cited in USDOI, MMS, 1982a). During public hearings in 1995, whaling captain Isaac Akootchook worried that an oil spill could occur under the ice and go unnoticed, causing significant damage to subsistence resources (Akootchook, 1995, as cited in USDOI, MMS, 1995c). At hearings for the Northstar Project, Fenton Rexford said:

> We know there are a lot of waterfowl that come from all over the world that go through this area, so that is one of the issues I would like to see in here [the EIS]. They come from all over the world for only a 3-month period, and if there is a spill, that would have a drastic effect (Rexford, 1996, as cited in Dames and Moore, 1996c).

IV.C.11.b(3) How Stipulations and Mitigating Measures Help Reduce Noise, Disturbance, and Oil-Spill Effects

Several mitigating measures are assumed to be in place for the Beaufort Sea multiple sales, and this assumption is reflected in discussions about effects. Mitigation that would apply to subsistence-harvest patterns includes standard proposed Stipulations 2 - Orientation Program, 4 - Industry Site-Specific Bowhead Whale Monitoring Program, and 5 - Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvest Activities. Proposed stipulations developed specifically for this EIS are Stipulation 6a - No Permanent Facility Siting in the Vicinity Seaward of Cross Island, 6b - No

Permanent Facility Siting in the Vicinity Shoreward of Cross Island, and 7 - Pre-booming Requirements for Fuel Transfers.

Stipulation 2 - Orientation Program requires the lessee to educate people working on exploration, development, and production about the environmental, social, and cultural concerns that relate to the area and its communities. The program should increase workers' sensitivity to, and understanding of, values, customs, and lifestyles of local Native communities and help prevent any conflicts with subsistence activities. The overall training program will be submitted to the Regional Supervisor, Field Operations for review and approval. Personnel will receive appropriate training on at least an annual basis, and full training records will be maintained for at least 5 years.

Stipulation 4 - Industry Site-Specific Bowhead Whale-Monitoring Program requires lessees proposing to conduct exploratory drilling operations, including seismic surveys, during the bowhead whale migration 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 the North Slope Borough (NSB) and the Alaska Eskimo Whaling Commission (AEWC), determines that a monitoring program is not necessary. The monitoring program would assess when bowhead whales are present in the vicinity of lease operations and the extent of behavioral effects on bowhead whales due to these operations.

This stipulation helps to provide mitigation to potential effects of oil and gas activities on the local Native whale hunters and subsistence users. It is considered as positive mitgation under environmental justice. Other positive aspects of this stipulation in terms of subsistence and sociocultural concerns would be the involvement of the Native community in the selection of peer reviewers and in providing observers for the monitoring effort.

Stipulation 5 - Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence Activities requires industry to avoid unreasonable conflict with subsistence activities during operations, especially the bowhead whale hunt. Before submitting a plan, the lessee must consult with the subsistence communities of Barrow, Nuiqsut, and Kaktovik; the North Slope Borough; and the Alaska Eskimo Whaling Commission about the proposed operations. These consultations ensure that they coordinate siting and timing with subsistence whaling and other subsistence-harvest activities.

In the event no agreement is reached between the parties, the lessee, the AEWC, the NSB, the National Marine Fisheries Service (NMFS), or any of the subsistence communities that could be affected directly by the proposed activity may request that the RS/FO assemble a group consisting of representatives from the subsistence communities, AEWC, NSB, NMFS, and the lessee(s) to specifically address the conflict and attempt to resolve the issues before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests. Upon request, the RS/FO will assemble this group, if the RS/FO determines such a meeting is warranted and relevant, before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests.

The MMS can restrict uses under the lease, if necessary, to prevent conflicts, but subsistence whalers and industry have been able to negotiate agreements that work for both parties. An example is the agreement coordinating the timing of seismic activity for the Northstar Project and the subsistence whale hunt. BPXA and the North Slope Borough, Alaska Eskimo Whaling Commission, and city of Nuiqsut worked out this agreement. Existing mitigation requires operators to coordinate siting and timing of projects in a Conflict Avoidance Agreement. The Alaska Eskimo Whaling Commission prefers to negotiate a Conflict Resolution Agreement with industry on an annual basis using a regional, rather than a project-specific, approach to address potential impacts from all ongoing development projects.

This stipulation helps to reduce noise and disturbance conflicts from oil and gas operations during specific periods, such as the annual spring and fall whale hunts. It requires that the lessees meet with local communities and subsistence groups to resolve potential conflicts. This stipulation reduces potential adverse effects from proposed sales to subsistence harvest patterns, sociocultural systems, and to environmental justice. This stipulation has proven to be effective mitigation in prelease (primarily seismic activities) and exploration activities and through the development of the annual oil/whaler agreement between the Alaska Eskimo Whaling Commission and oil companies.

Stipulation No. 6a - Permanent Facility Siting in the Vicinity Seaward of Cross Island would prohibit permanent OCS production facility siting within a defined 10-mile radius seaward of Cross Island unless the lessee demonstrates to the satisfaction of the Regional Director, in consultation with the North Slope Borough and the Alaska Eskimo Whaling Commission, that development would not preclude reasonable subsistence access to whales. In making such a demonstration, the lessee shall follow the processes and requirements for consultation and mitigation of unreasonable conflicts as set out in Stipulation 5.

This stipulation is divided into two parts. Stipulation 6a will apply the 10-mile radius around Cross Island outside of the barrier islands. Stipulation 6b will apply the 10-mile radius only to those blocks within the barrier islands.

This stipulation would reduce the potential conflict between subsistence hunting activities and oil and gas development and operational activities with the key areas seaward of Cross Island where subsistence whaling for the community of Nuiqsut occurs. This stipulation could also reduce potential noise from a facility in this area that could deflect bowhead whales further offshore.

Stipulation No. 6b, Permanent Facility Siting in the Vicinity Shoreward of Cross Island, would prohibit permanent OCS production facility siting within a defined 10-mile radius shoreward of Cross Island unless the lessee demonstrates to the satisfaction of the Regional Director, in consultation with the North Slope Borough and the Alaska Eskimo Whaling Commission, that development would not preclude reasonable subsistence access to whales.

This stipulation would reduce the potential conflict between subsistence hunting activities and oil and gas development and operational activities within the area shoreward of Cross Island. However, the whale migration and most whale hunting (based on the whale-strike data) occur outside the Barrier Islands. This stipulation would provide little or no additional protection to subsistence whaling or bowhead whales from that provided by Stipulation 5.

Stipulation 7 Pre-booming Requirements for Fuel Transfers, would require pre-booming of the fuel barges for fuel transfers (excluding gasoline transfers) of 100 barrels or more that occurred 3 weeks prior to or during the bowhead whale migration. The fuel barge would be surrounded by an oil-spill-containment boom during the entire transfer operation. This would help reduce any adverse effects from a potential spill.

This stipulation would lower the potential effects to subsistence resources and sociocultural systems by providing additional protection to the bowhead whale from potential fuel spills that could occur prior to or during the bowhead whale-migration period. This stipulation would be an added caution in reducing potential harm to migrating bowhead whales and to any tainting of the whales from a spill.

Conclusion. For the communities of Barrow, Nuiqsut and Kaktovik, disturbances periodically could affect subsistence resources, but no resource or harvest area would become unavailable and no resource population would experience an overall decrease. Disturbance and noise could affect subsistence species that include bowhead whales, seals, polar bears, caribou, fishes, and birds. Oil-spill cleanup would increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to these species and, therefore, alter or extend the normal subsistence hunt.

The chance of an oil spill occurring and entering offshore waters is estimated to be low. Based on the assumption that a spill has occurred, the chance of an oil spill during summer from a platform or a pipeline contacting important traditional bowhead whale- and seal-harvest areas over a 360-day period would be 75% or less for the Barrow whaling area, 41% or less for the Nuiqsut whaling area, and 34% or less for the Kaktovik whaling area. A spill also could affect other subsistence resources and harvest areas used by the communities of Barrow, Nuiqsut, and Kaktovik.

Overall, oil spills could affect subsistence *resources* periodically in the communities of Barrow, Nuiqsut, and Kaktovik. In the unlikely event of a large oil spill, many harvest areas and some subsistence resources could be unavailable for use. Some resource populations could suffer losses and, as a result of tainting, bowhead whales could be rendered unavailable for use. Tainting concerns in communities nearest the spill event could seriously curtail traditional practices for harvesting, sharing, and processing bowheads and threaten a pivotal element of Inupiat culture. There also is concern that the International Whaling Commission, which sets the quota for the Inupiat subsistence harvest of bowhead whales, would reduce the harvest quota following a major oil spill or, as a precaution, as the migration corridor becomes increasingly developed to ensure that overall population mortality did not increase. Such a move would have a profound cultural and nutritional impact on Inupiat whaling communities. Whaling communities distant from and unaffected by potential spill effects are likely to share bowhead whale products with impacted villages. Harvesting, sharing, and processing of other subsistence resources should continue but would be hampered to the degree these resources were contaminated. In the case of extreme contamination, harvests could cease until such time as resources were perceived as safe by local subsistence hunters. Overall, such effects are not expected from routine activities and operations. Tainting concerns also would apply to polar bears, seals, beluga whales, walruses, fish, and birds. Additionally, effects from a large oil spill likely would produce potential short-term but serious adverse effects to long-tailed duck and king and common eider populations.

All areas directly oiled, areas to some extent surrounding them, and areas used for staging and transportation corridors for spill response would not be used by subsistence hunters for some time following a spill. Oil contamination of beaches would have a profound impact on whaling because even if bowhead whales were not contaminated, Inupiat subsistence whalers would not be able to bring them ashore and butcher them on a contaminated shoreline. The duration of avoidance by subsistence users would vary depending on the volume of the spill, the persistence of oil in the environment, the degree of impact on resources, the time necessary for recovery, and the confidence in assurances that resources were safe to eat. Such oil-spill effects would be considered significant.

IV.C.11.c. Effects of Alternatives and Sales

Activities would concentrate in three geographic zones—Near, Midrange, and Far (Map 4)—based on water depth and their location to existing infrastructure. The Near Zone extends from the Colville River on the west to the Canning River on the east in waters from 0-10 meters deep. The Midrange Zone includes waters from 10-30 meters deep and extends from Cape Halkett on the west to Barter Island on the east. The Far Zone includes water depths greater than 40 meters and extends from just east of Barrow on the west to the U.S./Canadian Border on the east. Leasing and subsequent exploration and development activities would be concentrated in the Near Zone near existing infrastructure at Prudhoe Bay/Deadhorse for all three lease sales, especially Sale 186, but activities are projected to expand into deeper water and more remote areas in for Sales 195 and 202.

IV.C.11.c(1) Effects of Alternative I for Sale 186

The sale-specific effects from noise and disturbance and from oil spills under Alternative I for Sale 186 for subsistence resources generally are expected to be similar to those discussed under effects common to all alternatives earlier in this section.

Bowhead whales exposed to noise-producing activities most likely would experience temporary, nonlethal effects. Potential disturbance from seismic surveys in the central Beaufort Sea conducted during the open water season likely would be limited to areas west of Cross Island after September 1 under the provisions of a negotiated Conflict Avoidance Agreement between the operator and subsistence whalers and likely would have negligible effect on bowhead whales. Similar agreements between the operator and subsistence whalers are likely to be established for any seismic surveys proposed near Kaktovik or Barrow. Conflict avoidance agreements are primarily for the protection of the subsistence-whale hunt and allow for seismic work to proceed after the hunt is completed. Although the potential for seismic disturbance may be high, operators normally have concluded their seismic operations by this time (See Section IV.C.5 - Effects on Endangered and Threatened Species). Exposure of bowhead whales to spilled oil may result in lethal effects to a few individuals although most individuals exposed to spilled oil are expected to experience temporary, nonlethal effects. Overall, leasing, exploration, and production activities associated with Beaufort Sea Sale 186 are expected to have minimal effects on bowhead whales.

Effects associated with Alternative I for Sale 186 oil and gas exploration and development on other marine mammals are estimated to include the loss of perhaps 300 ringed seals, but probably fewer than 10-20 spotted and 30-50 bearded seals, fewer than 100 walrus, perhaps 5-30 polar bears, and fewer than 10 beluga and gray whales, with populations recovering within about 1 year.

Effects of Sale 186 Beaufort Sea oil exploration and development on caribou, muskoxen, grizzly bears, and arctic foxes are expected to include local displacement within about 0.62-1.2 miles along onshore pipelines, with local effects persisting during construction activities. Brief disturbances of groups of caribou and muskoxen from a few minutes to a few days could occur along pipeline corridors during periods of high ice-road and air traffic, but these disturbances are not expected to affect the movements and distribution of caribou, muskoxen, grizzly bears, and arctic foxes. In the unlikely event that a large oil spill occurs in the Beaufort Sea, it is expected to result in the loss of no more than a few hundred caribou and fewer than 10 individual muskoxen, grizzly bears, and arctic foxes, with recovery expected within about 1 year.

Measurable effects associated Alternative I for Sale 186 from oil exploration and development disturbance and oil spills are not expected on fish populations.

The effects of normal activities on marine and coastal birds under Alternative I for Sale 186 from oil and gas exploration and development are expected to be about the same as those described under effects common to all alternatives earlier in this section. The effects from activities associated with Alternative I for Sale 186 include nonsignificant disturbance and the potential loss of small numbers of birds from collision with structures. The risk of oil-spill contact is expected to be somewhat lower than if developments were spread throughout the planning area, which could include some areas used by marine and coastal birds that have higher oil-spill contact probabilities. Recovery from substantial oil-spill mortality is not likely to occur in any species whose population is in a declining status; however, determination of status may be obscured by natural variation in population numbers. Overall effects are expected to be somewhat less than those that could occur as a result of Sale 186, but still could result in significant effects for long-tailed ducks and common eiders.

Conclusion: Based on the sale-specific effects on subsistence resources mentioned above from noise, disturbance, and oil spills, the consequent effects on subsistence-harvest patterns under Alternative I for Sale 186 are expected to be similar to those discussed in effects common to all alternatives earlier in this section. Disturbance and noise could affect subsistence species that include bowhead whales, seals, polar bears, caribou, fishes, and birds. For the communities of Barrow, Nuiqsut, and Kaktovik, disturbances periodically could affect these subsistence resources, but no resource or harvest area would become unavailable and no resource population would experience an overall decrease. In the unlikely event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Oil-spill cleanup would increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to these species and, therefore, alter or extend the normal subsistence hunt.

IV.C.11.c(2) Effects of Alternatives III, V, and VI for Sale 186

Because these deferral areas are relatively far removed from primary support facilities in the vicinity of Deadhorse, it is less likely that leasing and development would occur there than in the central Beaufort area. Consequently, the effects of noise, disturbance, and oil spills on bowhead whales, seals, polar bears, and beluga and gray whales are expected to be about the same as described for Alternative I for Sale 186. The same would hold true for caribou, muskoxen, grizzly bears, and arctic foxes in addition to fish resources and birds. Differences in noise and oil spill effects to bowhead whales from these deferrals as compared to Alternative I for Sale 186 would likely be difficult to measure.

Conclusion: Effects on subsistence-harvest patterns are expected to be about the same as described under Alternative I for Sale 186.

IV.C.11c(3) Effects of Alternative IV for Sale 186

Under Alternative IV (Nuiqsut Subsistence-Whaling Deferral) for Sale 186, the effects of noise, disturbance, and oil spills on seals, polar bears, and beluga and gray whales are expected to be about the same as described for Alternative I for Sale 186. The same is true for caribou, muskoxen, grizzly bears, arctic foxes, and fishes.

Alternative IV for Sale 186 potentially could reduce noise and oil-spill effects to bowhead whales somewhat compared to Alternative I for Sale 186; however, any differences in effects between these deferrals and Alternative I for Sale 186 likely would be difficult to measure; therefore, the effects of noise and oil spills on bowhead whales are likely to be essentially the same as described for Alternative I for Sale 186. The effects from activities and any oil spill associated with Alternative IV for Sale 186 on spectacled eiders are expected to be somewhat less than under Alternative I for Sale 186. Effects on several marine and coastal bird species are expected to be somewhat less than under Alternative I for Sale 186; however, effects of an oil spill on regional populations of several species could be lowered substantially. Effects on subsistence-harvest patterns are expected to be reduced because no exploration or production activities would occur in these deferral areas, potentially reducing sources for chronic noise and disturbance effects on subsistence whaling. Effects from oil spills would not be diminished, because LA12 and P12 would not be excluded from the Oil-Spill-Risk Analysis scenario.

Conclusion: Even though effects on subsistence resources with Alternative IV for Sale 186 would be essentially the same as described for Alternative I for Sale 186, effects on subsistence-harvest patterns are expected to be reduced because no exploration or production activities would occur in these deferral areas, potentially reducing sources for chronic noise and disturbance effects on subsistence whaling. Effects from oil spills would not be diminished, because LA12 and P12 would not be excluded from the Oil-Spill-Risk Analysis scenario.

IV.C.11c(4) Effects of the Alternative I for Sale 195

The sale-specific effects from noise and disturbance and from oil spills under Alternative I for Sale 195 for subsistence resources generally are expected to be similar to those discussed under effects common to all alternatives earlier in this section.

Potential disturbances to bowhead whales would result from seismic surveys, drilling operations, vessel and air traffic, and construction activities. Because there would be no spill from launch areas or pipeline segments in the Far Zone, the chance of oil-spill contact for Alternative I for Sale 195 would be the same or slightly less for some environmental resource areas than those presented in the effects common to all alternatives section. Nevertheless, effects of exploration and production activities on bowhead whales under this Alternative are likely to be similar to those described under effects common to all alternatives and in effects of Alternative I for Sale 186. Although more activities are expected to occur in deeper water, the differences in effects to bowhead whales between the two sale scenarios probably are not measurable.

Effects associated with Alternative I for Sale 195 on other marine mammals are estimated to include the loss of perhaps 300 ringed seals but probably fewer than 10-20 spotted and 30-50 bearded seals, fewer than 100 walruses, perhaps 5-30 polar bears, and fewer than 10 beluga and gray whales, with populations recovering within about 1 year.

Effects of Alternative I for Sale 195 on caribou, muskoxen, grizzly bears, and arctic foxes are estimated to include local displacement within about 0.62-1.2 miles along onshore pipelines, with local effects persisting during construction activities. Brief disturbances of groups of caribou and muskoxen from a few minutes to a few days could occur along pipeline corridors during periods of high ice-road and air traffic, but these disturbances are not expected to affect the movements and distribution of caribou, muskoxen, grizzly bears, and arctic foxes. In the unlikely event that a large oil spill occurred in the Beaufort Sea, it likely would result in the loss of no more than a few hundred caribou and fewer than 10 individual muskoxen, grizzly bears, and arctic foxes, with recovery expected within about 1 year.

Measurable effects associated with Alternative I for Sale 195 from oil exploration and development disturbance and oil spills are not expected on fish populations.

The effects of normal activities on marine and coastal birds under Alternative I for Sale 195 from oil and gas exploration and development are expected to be about the same as those described under effects common to all alternatives earlier in this section. The effects from activities associated with Alternative I for Sale 195 include nonsignificant disturbance and the potential loss of small numbers of birds from collision with structures. Disturbance of birds in the Near Zone likely would be lower than under Alternative I for Sale 186, because a lower proportion of leasing and exploration is expected to occur there, while lease activity in the Midrange Zone is somewhat greater but the number of development projects is the same. The risk of oil-spill contact is expected to be somewhat lower than for Alternative I for Sale 186, which proposes one more development project than Alternative I for Sale 195, or if developments were spread throughout the planning area, which could include some areas used by marine and coastal bird species that have higher probabilities of oil-spill contact. Recovery from substantial oil-spill mortality likely would occur in any species whose population is in a declining status; however, the determination of status may be obscured by natural variation in population numbers. Overall effects likely would be somewhat less than those expected for Alternative I for Sale 186 but still could result in significant effects for long-tailed ducks and common eiders.

Conclusion: Based on the sale-specific effects on subsistence resources from noise, disturbance, and oil spills, the consequent effects on subsistence-harvest patterns under Alternative I for Sale 195 are expected to be similar to those discussed under effects common to all alternatives earlier in this section. Disturbance and noise could affect subsistence species that include bowhead whales, seals, polar bears, caribou, fishes, and birds. For the communities of Barrow, Nuiqsut, and Kaktovik, disturbances periodically could affect these subsistence resources, but no resource or harvest area would become unavailable and no resource population would experience an overall decrease. In the unlikely event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Oil-spill cleanup would increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to these species and, therefore, alter or extend the normal subsistence hunt.

IV.C.11.c(5) Effects of Alternative III, V, and VI for Sale 195

Because these deferral areas are relatively far removed from primary support facilities in the vicinity of Deadhorse, it is less likely that leasing and development would occur there than in the central Beaufort area. The difference in effects from noise, disturbance, and oil spills on bowhead whales from these deferrals as compared to Alternative I for Sale 195 likely would be difficult to measure. Similarly, effects on seals, polar bears, and beluga and gray whales are expected to be about the same as described for Alternative I for Sale 195. The same is true for caribou, muskoxen, grizzly bears, and arctic foxes in addition to fish resources and birds.

Conclusion: Effects on subsistence-harvest patterns are expected to be about the same as described for Alternative I for Sale 195.

IV.C.11.c(6) Effects of Alternative IV for Sale 195

Under Alternative IV for Sale 195, the effects of noise, disturbance, and oil spills on seals, polar bears, and beluga and gray whales are expected to be about the same as described for Alternative I for Sale 195. The same is true for caribou, muskoxen, grizzly bears, arctic foxes, and fishes.

Alternative IV for Sale 195 potentially could reduce noise and oil spill effects to bowhead whales somewhat compared to Alternative I for Sale 195; however, any differences in effects between this deferral and Alternative I for Sale 195 likely would be difficult to measure; therefore, the effects of noise and oil spills on bowhead whales are likely to be essentially the same as described in effects of Alternative I for Sale 195. The effects from activities and any oil spill associated with Alternative IV for Sale 195 on spectacled eiders are expected to be somewhat less than under Alternative I for Sale 195. Effects on several bird species are expected to be somewhat less than under Alternative I for Sale 195; however, effects of an oil spill on regional populations of several species could be lowered substantially. Effects on subsistence-harvest patterns in Nuiqsut are expected to be reduced because no exploration or production activities would occur in these deferral areas, potentially reducing sources for chronic noise and disturbance effects on subsistence whaling. Effects from oil spills would not be diminished, because LA12 and P12 would not be excluded from the Oil-Spill-Risk Analysis scenario.

Conclusion: Even though effects on subsistence resources with Alternative IV for Sale 195 would be essentially the same as described for Alternative I for Sale 195, effects on subsistence-harvest patterns in Nuiqsut are expected to be reduced, because no exploration or production activities would occur in these deferral areas, potentially reducing sources for chronic noise and disturbance effects on subsistence whaling. Effects from oil spills would not be diminished, because LA12 and P12 would not be excluded from the Oil-Spill-Risk Analysis scenario.

IV.C.11.c(7) Effects of Alternative I for Sale 202

The sale-specific effects from noise and disturbance and from oil spills under Alternative I for Sale 202 for subsistence resources generally are expected to be similar to those discussed under effects common to all alternatives.

The effects of noise, disturbance, and oil spills on bowhead whales are likely to be essentially the same as described under effects common to all alternatives and in effects of Alternative I under Sales 186 and 195. Although more activities are expected to occur in deeper waters than in Alternative I for Sales 186 and 195, the differences in effects to bowhead whales between Alternative I for Sale 202 and Alternative I for Sales 186 and 195 probably are not measurable.

Effects associated with Alternative I for Sale 202 on other marine mammals are estimated to include the loss of perhaps 300 ringed seals but probably fewer than 10-20 spotted and 30-50 bearded seals, fewer than 100 walruses, perhaps 5-30 polar bears, and fewer than 10 beluga and gray whales, with populations recovering within about 1 year.

Effects of Sale 202 on caribou, muskoxen, grizzly bears, and arctic foxes are expected to include local displacement within about 0.62-1.2 miles along onshore pipelines, with local effects persisting during construction activities. Brief disturbances of groups of caribou and muskoxen from a few minutes to a few days could occur along pipeline corridors during periods of high ice-road and air traffic, but these disturbances are not expected to affect the movements and distribution of caribou, muskoxen, grizzly bears, and arctic foxes. In the unlikely event that a large oil spill occurred in the Beaufort Sea, it is expected to result in the loss of no more than a few hundred caribou, and less than 10 individual muskoxen, grizzly bears, and arctic foxes, with recovery expected within about 1 year.

Measurable effects associated with Alternative I for Sale 202 from oil exploration and development disturbance and oil spills are not expected on fish populations.

The effects on marine and coastal birds from activities associated with Alternative I for Sale 202 include a small amount of nonsignificant disturbance and the potential loss of small numbers of birds from collision with structures. The risk of oil-spill contact is relatively low, because only one development is expected, most likely located where most species are relatively scarce. Effects are expected to be considerably less than those that could occur as a result of Alternative I for Sales 186 or 195.

Conclusion: Based on the sale-specific effects on subsistence resources from noise, disturbance, and oil spills, the consequent effects on subsistence-harvest patterns for Alternative I for Sale 202 are expected to be similar to those discussed previously in this section under effects common to all alternatives. Disturbance and noise could affect subsistence species that include bowhead whales, seals, polar bears, caribou, fishes, and birds. For the communities of Barrow, Nuiqsut, and Kaktovik, disturbances periodically could affect these subsistence resources, but no resource or harvest area would become unavailable and no resource population would experience an overall decrease. In the unlikely event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Oil-spill cleanup would increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to these species and, therefore, alter or extend the normal subsistence hunt.

IV.C.11.c(8) Effects of Alternative III for Sale 202

Effects on bowhead whales, caribou, muskoxen, grizzly bears, arctic foxes, fish resources, and birds are expected to be about the same as described for Alternative I for Sale 202. Differences in noise and oil-spill effects to bowhead whales from this deferral as compared to Alternative I for Sale 202 likely would be difficult to measure.

This alternative is not expected to potentially reduce noise, disturbance, and oil-spill effects on seals, polar bears, and gray and beluga whales from air and vessel traffic, drill platforms or reduce habitat effects from platform and offshore pipeline installation in this area, and effects are expected to be the same as for Alternative I for Sale 202. However, potential risks of oil-spill contact to the Barrow subsistence whaling area (ERA 42) would be reduced with the partial removal of the highest conditional risk, a 64% chance of contact to this area from launch area LA2. Spill-contact risks to other habitat areas would not be reduced under this alternative for Sale 202. Potential noise and oil-spill effects east of Cape Halkett would be the same as described for Alternative I for Sale 202.

Conclusion: Because no exploration or production activities would occur in this deferral area under Alternative III for Sale 202, potential oil-spill, chronic noise, and disturbance effects under Alternative IV for Sale 202 on subsistence whaling and on Barrow's traditional subsistence-whaling area would be reduced.

IV.C.11.c(9) Effects of Alternative IV for Sale 202

Effects on bowhead whales, seals, polar bears, beluga and gray whales, caribou, muskoxen, grizzly bears, arctic foxes, and fish resources are expected to be about the same as described for Alternative I for Sale 202. Differences in noise and oil-spill effects to bowhead whales from this deferral compared to Alternative I for Sale 202 are not likely to be measurable.

Alternative IV for Sale 202 would defer leasing and development in central Beaufort Sea areas, where several species of marine and coastal birds are relatively abundant. Although this deferral would lower the probability of eider contact from oil in this area if an oil spill were to occur, most spectacled eiders occur west of the Sagavanirktok River, and the deferred area is located east of the primary area of eider distribution. As a result, the effects from noise, disturbance, and any oil spill associated with Alternative IV for Sale 202 on spectacled eiders are expected to be somewhat less than under Alternative I for Sale 202.

Conclusion: Although effects on subsistence resources under Alternatives V and IV for Sale 202 would be essentially the same as described for Alternative I for Sale 202, effects on subsistence-harvest patterns in Nuiqsut are expected to be reduced, because no exploration or production activities would occur in this deferral area, potentially reducing sources for chronic noise and disturbance effects on subsistence whaling. Effects from oil spills would not be diminished, because LA12 and P12 would not be excluded from the Oil-Spill-Risk Analysis scenario.

IV.C.11.c(10) Effects of Alternative V for Sale 202

Effects on bowhead whales, seals, polar bears, beluga and gray whales, caribou, muskoxen, grizzly bears, arctic foxes, fish resources, and birds are expected to be about the same as described for Alternative I for Sale 202. Differences in noise and oil-spill effects to bowhead whales from this deferral alternative compared to Alternative I for Sale 202 are not likely to be measurable.

Conclusion: Even though effects on subsistence resources with Alternative V for Sale 202 would be essentially the same as described for Alternative I for Sale 202, effects on subsistence-harvest patterns in Kaktovik are expected to be reduced, because no exploration or production activities would occur in this deferral area, potentially reducing sources for chronic noise and disturbance effects on subsistence whaling and the western half of Kaktovik's traditional subsistence-whaling area.

IV.C.11.c(11) Effects of Alternative VI for Sale 202

Effects on bowhead whales, fish resources, and birds are expected to be about the same as described for Alternative I for Sale 202. Differences in oil-spill and noise effects to bowhead whales from this deferral alternative as compared to Alternative I for Sale 202 are not likely to be measurable.

This alternative potentially could reduce oil-spill effects on seals, polar bears, gray and beluga whales, caribou, muskoxen, grizzly bears, and arctic foxes from about Barter Island east to Demarcation Bay. Potential oil-spill contact to offshore habitats for seals, polar bears, and beluga whales from about Barter Island east to Herschel Island would be reduced somewhat, if oil exploration and development were deferred under this alternative. Potential oil-spill risks to habitats west of Beaufort Lagoon would be the same as described under effects common to all alternatives earlier in this section.

Conclusion: Potential reductions in oil-spill contact to seals, polar bears, gray and beluga whales, caribou, muskoxen, grizzly bears, and arctic foxes from about Barter Island east to Demarcation Bay would reduce effects on these important subsistence resources and on important Kaktovik subsistence harvest areas.

IV.C.12. Sociocultural Systems

IV.C.12.a. Effects of Noise, Disturbance, and Oil Spills on Sociocultural Systems

This discussion is concerned with those communities that potentially could be affected by activity generated by the Beaufort Sea multiple sales. These include the communities of Barrow, Nuiqsut, and Kaktovik. The primary aspects of the sociocultural systems covered in this analysis are (1) social organization, (2) cultural values, and (3) social health as described in Section III.C.3. For purposes of analysis, it is assumed that effects on social organization and cultural values could be brought about at the community level by increased population, by increased employment, and by effects on subsistence-harvest patterns predominantly from oil and gas leasing and associate exploration, development, and production associated with the sale. Potential effects are evaluated relative to the tendency of introduced social forces to support or disrupt existing systems of organization, relative to how rapidly they occur and their duration (see Langdon, 1996).

North Slope Inupiat continue to express concern about the differences in how they and the dominant culture relate to the land and waters. Rex Okakok from Barrow expressed the problem when he said “Our land and sea are still considered and thought by outsiders to be the source of wealth, a military arena, a scientific laboratory, or a source of wilderness to be preserved, rather than as a homeland of our Inupiat” (USDOI, MMS, 1987a). Considering such use of Inupiat territory, Robert Edwardson from Barrow said that he would like to see revenues paid to the Inupiat for mineral rights (USDOI, MMS, 1995b).

IV.C.12.a(1) General Effects from Noise and Disturbance

IV.C.12.a(1)(a) Social Organization

An analysis of the effects on sociocultural systems must first look at the social organization of a society that involves examining how people are divided into social groups and networks. Social groups generally are based on kinship and marriage systems and on nonbiological alliance groups formed by such characteristics as age, sex, ethnicity, community, and trade. Kinship relations and nonbiological alliances serve to extend and ensure cooperation within the society. Social organization could be affected by an influx of new population that causes growth in the community and change in the organization of social groups and networks.

Disruption of the subsistence cycle also could change the way these groups are organized. The sharing of subsistence foods is profoundly important to the maintenance of family ties, kinship networks, and a sense of community well-being. In rural Alaskan Native communities, task groups associated with subsistence harvests are important in defining social roles and kinship relations: the individuals one cooperates with help define kin ties, and the distribution of specific tasks reflects and reinforces the roles of husbands, wives, grandparents, children, friends, and others. Disruption of these task groups can damage social bonds that hold a community together. Any serious disruption of sharing networks can appear as a threat to the established way of life in a community and can trigger an array of negative emotions—fear, anger, and frustration—in addition to a sense of loss and helplessness. Because of the psychological importance of subsistence in these sharing networks, perceived threats to subsistence activities from oil development are a major cause for anxiety.

An Alaska Department of Fish and Game social-effects survey administered by the Division of Subsistence Management in 1994 in Nuiqsut included questions on effects from OCS development. One question asked was: “How do you think the offshore development of oil and gas in this area would affect the following resources available for harvest; would the resource decrease, not change, or increase?” Eighty-percent of Nuiqsut respondents answered that fish resources would decrease, 87% said marine mammals would decrease, 43% said land mammals would decrease, and 55% said that birds would decrease; 67% were not in favor of the search for oil, and 42% believed the search for oil would have an adverse impact on subsistence; 68% were not in favor of the development and production of oil, and 52% believed that oil development and production would have an adverse impact on subsistence (Fall and Utermohle, 1995).

An analysis of cultural values shows those values that are shared by most members of a social group. Generally, these values reflect what is desirable and represent what is accepted, explicitly or implicitly, by members of a social group. Forces powerful enough to change the basic values of an entire society would include a seriously disturbing change in the physical conditions of life—a fundamental cultural change imposed or induced by external forces. One example would be an incoming group that demands that residents accept their intrusive culture's values. Another would be a basic series of technological inventions that change physical and social conditions. Such changes in cultural values can occur slowly and imperceptibly or suddenly and dramatically (Lantis, 1959). Disturbance from oil development may be such a change that could bring about dramatic changes to cultural values on the North Slope, including strong ties to Native foods, to the land and its wildlife, to the family, to the virtues of sharing the proceeds of the hunt, and to independence from institutional and political forces outside the North Slope (see Section III.C.3). A serious disruption of subsistence-harvest patterns could alter these cultural values.

For the system of sharing to operate properly, some households must be able to produce, rather consistently, a surplus of subsistence goods; it is obviously more difficult for a household to produce a surplus than to simply satisfy its own needs. For this reason, sharing, and the supply of subsistence foods in the sharing network, often is more sensitive to harvest disruptions than the actual harvest and consumption of these foods by active producers. Thus, when oil-development disturbance occurs, it may disrupt a community's culture, even though it does not cause "biologically significant" harm to a subsistence species' overall population.

IV.C.12.a(1)(b) Population and Employment

Employment projections as a consequence of Beaufort Sea multiple-sale activities are provided in Section IV.C.10 - Economic Effects.

There may be some degree of development-induced local employment, but these changes, particularly as they translate into Native employment, historically have been and are expected to continue to be insignificant. Even though Native employment in oil-related jobs on the North Slope is low, Native leaders continue to push for programs and processes with industry that encourage more Native hire. The North Slope Borough has attempted to facilitate Native employment in the oil industry at Prudhoe Bay and is concerned that the industry has not done enough to accommodate training of unskilled laborers or to accommodate their cultural needs in participating in subsistence hunting. The North Slope Borough also is concerned that industry recruits workers using methods more common to Western industry practices and would like to see the oil industry make a more concerted effort, and one that is more appropriate to the Inupiat, to hire North Slope Borough residents. Few village residents currently are employed by the oil industry, even though recruitment efforts are made and training programs are available.

Many of the contractors hired by the oil industry in the Oil Patch are either North Slope Native corporations (Arctic Slope Regional Corporation et al.), subsidiaries of such corporations, or otherwise affiliated with such corporations through joint ventures and other relationships. This situation provides significant local economic benefit. One slope operator, BPXA, has instituted its Itqanaiyagvik hiring and training program, designed to put more Inupiat into the oil field workforce. It is a joint venture with the Arctic Slope Regional Corporation and its oil-field subsidiaries and is coordinated with the North Slope Borough and the North Slope Borough School District. Other initiatives are an adult "job-shadowing" program, and an effort called Alliances of Learning and Vision for Under Represented Americans, developed with the University of Alaska to prepare candidates for degree programs in technical and engineering professions. Most graduates of the adult job-shadowing program already are working in oil-field jobs (BPXA, 1998c). Iligsavik College in Barrow was specifically established to train young Natives for work in the oil fields.

IV.C.12.a(2) Specific Effects of Noise and Disturbance

Because staging would be from existing infrastructure in Deadhorse, social systems in the communities of Barrow, Nuiqsut, and Kaktovik would experience little direct disturbance from the staging of people and aircraft transportation for exploration and development for the Beaufort Sea multiple sales. These activities are expected to have little effect on sociocultural systems. Oil workers likely would not interact with

Barrow, Nuiqsut, or Kaktovik residents, and there would be no expected displacement of social systems. Also, changes in population and employment are not likely to disrupt sociocultural systems.

Stress would occur if a village were not successful in the bowhead whale harvest, with potential disruption of sharing networks and task groups. This stress could disrupt the community's social organization but likely would not displace the long-term social processes of whaling and sharing. Other more successful villages would share with a village having an unsuccessful whaling season. More recently, there have been no unsuccessful whaling seasons for Nuiqsut since 1994 and Kaktovik since 1991 (Braund, Marquette, and Bockstoce, 1988; Alaska Eskimo Whaling Commission, 1987-1995). Negotiated conflict resolution agreements between the Alaska Eskimo Whaling Commission, subsistence-whaling communities, and the oil industry have successfully served as a means to coordinate whaling activities and potential disturbance to whaling from industry activities.

Any effects on social health would have ramifications on social organization. On the other hand, North Slope Borough Native communities have, in fact, proven quite resilient to such effects with the Borough's continued support of Inupiat cultural values and its strong commitment to health, social service, and other assistance programs. Health and social-service programs have attempted to meet the needs of alcohol- and drug-related problems by providing treatment programs and shelters for wives and families of abusive spouses and by placing greater emphasis on recreational programs and services. However, in comments before the Department of the Interior's OCS Policy Committee's May 2000 meeting, North Slope Borough Mayor George Ahmaogak stated that Borough residents are extremely concerned that a lack of adequate financing for local North Slope Borough city governments has hampered the development of these programs, and declining revenues from the State of Alaska have seriously impaired the overall function of these city governments. Partnering together, Tribal governments, city governments, and the North Slope Borough government have been able to provide some programs, services, and benefits to local residents. For several years, all communities in the Borough have banned the sale of alcohol, although alcohol possession is not banned in Barrow, and many communities are continually under pressure to bring the issue up in local referendums (North Slope Borough, 1998).

Effects on social health in Nuiqsut would have direct consequences on sociocultural systems but would not tend toward the displacement of existing systems above the displacement that has already occurred with the current level of development. Effects in Barrow and Kaktovik would be periodic and would not displace existing sociocultural systems.

Native Views on Disturbance. At hearings in 1982, Mark Ahmakak from Nuiqsut stated that there should be economic benefits to Nuiqsut, such as cheaper diesel (Ahmakak, 1982, as cited in USDOI, MMS, 1982b). The consensus is that some benefit should come to the community from nearby oil activities. Nuiqsut resident Joseph Ericklook expressed the community's wish to see employment opportunities for local people result from development (Ericklook, 1990, as cited in USDOI, MMS, 1990d). In a 1996 public meeting for the Northstar Project, a Nuiqsut elder stated that she wanted potential human-health issues that could result from the project looked into beforehand. These issues could be found in information from other projects. She specifically expressed concern about cancers, health problems related to air pollution, and shortened lifespans (Dames and Moore, 1996d). As early as 1983, Nuiqsut residents asked to be part of industry activities in the region. Mark Ahmakak stated: "I think that if you are going to go ahead with this sale that you should utilize Natives in the areas affected by this lease sale; then utilize some of these Natives as monitors on some of your projects" (Ahmakak, 1983, as cited in USDOI, MMS, 1983a). There are concerns about protecting traditional sites from development. Nannie Woods expressed her opposition to leasing in the Colville River Delta because of her concern that her husband's burial site might be disturbed by development (Woods, 1982, as cited in USDOI, MMS, 1982b). Recently, a Nuiqsut elder had her "home place" at Prudhoe Bay desecrated by an oil company. Her house was looted and built over. She emphasized that graves of family members are in the area and that she has been denied access there (Dames and Moore, 1996d). At a November 1999 MMS Liberty Project Information Update Meeting in Nuiqsut, Elders told MMS to be aware of gravesites on the shoreline of Foggy Island Bay.

Former Mayor Lon Sonsalla of Kaktovik believes that to keep up with development activities, the village needs an impact office there to review EIS documents and monitor offshore activities (Sonsalla, 1996, as cited in USDOI, MMS, 1996d). During MMS scoping meetings for Sale 170, in November 1996, Susie Akootchook, Village Coordinator for Kaktovik, commented that traditional fishing and hunting sites need protection, and that a contingency plan needs to be developed to protect them (Burwell, 1996, pers. commun.).

Rex Okakok from Barrow expressed a fundamental problems for Inupiaq culture from outside interests, saying: "Our land and sea are still considered and thought by outsiders to be the source of wealth, a military arena, a scientific laboratory, or a source of wilderness to be preserved, rather than as a homeland of our Inupiat" (Okakok, 1987, as cited in USDOI, MMS, 1987a). Considering such use of Inupiat territory, Robert Edwardson from Barrow said that he would like to see revenues paid to the Inupiat for mineral rights (Edwardson, 1995, as cited in USDOI, MMS, 1995b). All three communities believe that some form of impact assistance should be forthcoming to compensate them for absorbing the social impacts from oil development that have occurred and that are to come.

IV.C.12.a(3) Effects from Oil Spills

IV.C.12.a(3)(a) General Effects from Oil Spills

Effects on the sociocultural systems of local communities could come from disturbance from small changes in population and employment, periodic interference with subsistence-harvest patterns from oil spills and oil-spill cleanup, and stress due to fears of a potential spill and the disruptions it would cause. Traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term if there are concerns over the tainting of bowhead whales from an oil spill, but overall effects from these sources are not expected to displace ongoing sociocultural systems. Oil-spill employment (response and cleanup) could disrupt subsistence-harvest activities for at least an entire season and disrupt some sociocultural systems, but most likely, it would not displace these systems. The sudden employment increase could have sudden and abnormally high effects, including inflation and displacement of Native residents from their normal subsistence-harvest activities by employing them as spill workers. Cleanup employment of local Inupiat also could alter normal subsistence practices and put stresses on local village infrastructures by drawing local workers away from village service jobs.

IV.C.12.a(3)(b) Specific Effects on Sociocultural Systems

Effects on the sociocultural systems of the communities of Barrow, Nuiqsut, and Kaktovik could come from disturbance from small changes in population and employment and periodic interference with subsistence-harvest patterns from oil spills and oil-spill cleanup. Effects from these sources are not expected to displace ongoing sociocultural systems, but community activities and traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term, if there are concerns over the tainting of bowhead whales from an oil spill.

Because development and production activities would be enclave based, stresses to the local village infrastructure, health care, and emergency response systems are expected to be minimal. Demands on local village infrastructures from construction, operation, maintenance, and abandonment activities would not be expected, because all these activities would be staged out of Prudhoe Bay.

Stress created by the fear of an oil spill also is a distinct predevelopment impact-producing agent within the human environment. Stress from this general fear can be broken down to the particular fears of:

- being inundated during cleanup with outsiders who could disrupt local cultural continuity;
- the damage that spills would do to the present and future natural environment;
- drawn out oil-spill litigation;
- contamination of subsistence foods;
- lack of local resources to mobilize for advocacy and activism with regional, State, and Federal agencies;
- lack of personal and professional time to interact with regional, State, and Federal agencies;
- retracing the steps (and the frustrations involved) taken to oppose offshore development;
- responding repeatedly to questions and information requests posed by researchers and regional, State, and Federal outreach staff; and
- having to employ and work with lawyers to draft litigation in attempts to stop proposed development.

A State of Alaska Department of Fish and Game social-effects survey administered by the Division of Subsistence Management in 1994 in Nuiqsut included questions on effects from OCS development. Sixty-percent of the respondents did not believe a small oil spill could be contained or cleaned up, and 80% did not believe a large oil spill could be contained or cleaned up. The overall study on 21 Alaskan communities concluded that impacts persist from the *Exxon Valdez* oil spill on subsistence use and the social and cultural system that subsistence activities support (Fall and Utermohle, 1995; Impact Assessment, Inc., 1998; Field et al., 1999).

A study by Picou et al. (1992) showed that 18 months following the *Exxon Valdez* spill, residents of Cordova had experienced long-term negative social effects—disruption to work roles and increased personal stress. Additionally, they observed that:

> work disruption was correlated with intrusive stress and fishermen experienced more work disruption than other occupations. It may be possible that other natural resource community activities such as participation in subsistence harvests may identify subpopulations more vulnerable to long-term negative social impacts (Picou et al., 1992).

Another good source of information on spill effects is *the Social Indicators Study of Alaskan Coastal Villages, Volume VI: Analysis of the Exxon Valdez Spill Area, 1988-1992* (Human Relations Area Files, Inc., 1994). The summary of findings section affirmed that, immediately after the spill and continuing into early 1990, Native people decreased their harvests of wild resources and relied on preserved foods harvested before the spill. By the winter of 1991, the Natives' normal harvesting activities had begun to resume, but the proportions of wild foods in their diets remained below those of 1989. The study also demonstrated in its analysis that non-Natives and Natives "define the environment and resources within the environment very differently. Commodity valuation takes precedence" for non-Natives and "instrumental use and cultural and spiritual valuation take precedence" for Native people (Human Relations Area Files, Inc., 1994).

IV.C.12.a(3)(c) Effects of Cleanup Activities on Sociocultural Systems

The likelihood of an oil spill from the Beaufort Sea multiple sales is low. However, if one occurred, oil-spill employment (response and cleanup) could disrupt subsistence-harvest activities for at least an entire season and disrupt some sociocultural systems. Most likely, it would not displace these systems. If a large spill contacted and extensively oiled coastal habitats, the presence of hundreds of humans, boats, and aircraft would displace subsistence species and alter or reduce access to these species by subsistence hunters. Employment generated to clean up an oil spill of 1,500 or 4,600 barrels could call for 60 or 190 cleanup workers. This rapid employment increase could have sudden and abnormally high effects, including inflation and displacement of Native residents from their normal subsistence-harvest activities by employing them as spill workers. Cleanup is unlikely to add population to the communities, because administrators and workers would live in separate enclaves; cleanup employment of local Inupiat could alter normal subsistence practices and put stresses on local village infrastructures by drawing local workers away from village service jobs.

Industry oil-discharge prevention and cleanup-contingency plans would be expected to include scenarios for cleaning up oil in open water, solid ice, and broken ice. These scenarios would have to identify logistics, equipment, and tactics for the various cleanup responses. Spill cleanup would reduce the amount of spilled oil in the environment and tend to mitigate spill effects. A decline in the certainty about the safety of subsistence foods, potential displacement of subsistence resources and hunters, and changes in sharing and visiting could lead to a loss of community solidarity. Far from providing mitigation, oil-spill cleanup activities more likely should be viewed as an additional impact, causing displacement and employment disruptions (see Impact Assessment, Inc., 1998).

Native Allotments. Native allotments are considered Indian trust resources (lands). These allotments are small land parcels (up to 160 acres) given to families for private use in accordance with the Alaska Native Allotment Act of 1906. The use or lease of these allotments requires consensus of all family heirs and the approval of the Bureau of Indian Affairs. If Native allotments were in the vicinity of proposed onshore infrastructure (pipelines, landfalls, pump stations), allotment holders would be identified and notified about local public hearings on sale activities and sent copies of the draft EIS for review and comment.

Environmental Justice. For a discussion of Environmental Justice, see Section IV.C.16.

IV.C.12.a(4) How Stipulations or Mitigating Measures Help Reduce Disturbance Effects

See Section IV.C.11 Effects on Subsistence-Harvest Patterns, for a discussion of mitigating measures that would help reduce disturbance and oil-spill effects on sociocultural systems. We assume 5 standard stipulations and 16 standard ITL clauses are in place for Beaufort Sea multiple sale activities, and this assumption is reflected in discussions about effects.

At a town meeting for the Northstar Project, Nuiqsut residents reiterated that they do not believe the technology exists to clean up an oil spill under the ice; they believe it is a matter of when a spill will occur, not if it will occur. They want assurance against disaster and want impact funds set aside for them if a spill occurs (Dames and Moore, 1996a). Earlier village comments expressed the same attitude.

In 1979, Gordon Rankin from Kaktovik suggested that a compensation fund be set aside for villages, in case there is a devastating oil spill (Rankin, 1979, as cited in USDOI, Bureau of Land Management, 1979b).

Barrow resident Charles Okakok said that subsistence users should be compensated by the oil industry in case of an oil spill (Okakok, 1995, as cited in USDOI, MMS, 1995b). Natives living on the North Slope often have repeated this sentiment.

Nuiqsut residents clearly want to be active in any spill response and cleanup. At a community meeting for the Northstar Project, the people of Nuiqsut said they wanted to be part of a newly formed village oil-spill-response team, so that they could positively contribute in an emergency situation (Dames and Moore, 1996d). Their involvement in the past has not always gone smoothly. At the same community meeting, two Nuiqsut men felt their skills and knowledge were not respected when asked to participate in an oil-spill-response drill on a rig near the Northstar Project in February 1991. They believed their skills and knowledge could have been better used by the command structure of that team (Dames and Moore, 1996d).

Conclusion of Noise, Disturbance, and Oil-Spill Effects from Beaufort Sea Multiple-Sale Exploration and Development: Effects on the sociocultural systems of the communities of Barrow, Nuiqsut, and Kaktovik could come from disturbance from industrial activities, from changes in population and employment, and from periodic interference with subsistence-harvest patterns from oil spills and oil-spill cleanup. Altogether, effects periodically could disrupt but not displace ongoing social systems, community activities, and traditional practices for harvesting, sharing, and processing subsistence resources. However, in the unlikely event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Such impacts would be considered significant. All subsistence whaling communities and other communities that trade for and receive whale products and other resources from the whaling communities could be affected. A large spill anywhere within the habitat of bowhead whales or other important migratory subsistence resources could have multiyear impacts on the harvest of these species by all communities that use them. In addition, harvests could be affected by the International Whaling Commission to limit harvest quotas in response to a perceived increased threat to the bowhead whale population. Beyond the impacts of a large spill, long-term deflection of whale migratory routes or increased skittishness of whales due to increased industrialization in the Beaufort Sea would make subsistence harvests more difficult, dangerous, and expensive. To date, no long-term deflections of have bowheads have been demonstrated.

IV.C.12.b. Effects by Alternatives and Sales

Activities would concentrate in three geographic zones—Near, Midrange, and Far—based on water depth and their location to existing infrastructure. The Near Zone extends from the Colville River on the west to the Canning River on the east in waters from 0-10 meters deep. The Midrange Zone includes waters from 10-30 meters deep and extends from Cape Halkett on the west to Barter Island on the east. The Far Zone includes water depths greater than 40 meters and extends from just east of Barrow on the west to the U.S./Canadian Border on the east. Leasing and subsequent exploration and development activities would be concentrated in the Near Zone near existing infrastructure at Prudhoe Bay/Deadhorse for all three lease sales, especially Sale 186; however, activities are projected to expand into deeper water and more remote areas in for Sales 195 and 202.

IV.C.12.b(1) Alternatives

IV.C.12.b(1)(a) Effects of Alternative I for Sale 186

Sale-specific effects from population and employment, noise and disturbance, and oil spills under Alternative I for Sale 186 for sociocultural systems generally are expected to be similar to those discussed under effects common to all alternatives.

Conclusion: Based on the sale-specific effects on subsistence resources discussed in Section IV.C.11 - Subsistence-Harvest Patterns, the consequent effects on sociocultural systems under Alternative I for Sale 186 are expected to be similar to those discussed under effects common to all alternatives. Altogether, effects periodically could disrupt but not displace ongoing social systems; community activities; and traditional practices for harvesting, sharing, and processing subsistence resources. However, in the unlikely event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Such impacts would be considered significant.

IV.C.12.b(1)(b) Effects of the Alternative I for Sale 195

Sale-specific effects from population and employment, noise and disturbance, and oil spills under Alternative I for Sale 195 for sociocultural systems generally are expected to be similar to those discussed under effects common to all alternatives earlier in this section.

Conclusion: Based on the sale-specific effects on subsistence resources discussed in IV.C.11 - Subsistence-Harvest Patterns, the consequent effects on sociocultural systems under Alternative I for Sale 195 are expected to be similar to those discussed under effects common to all alternatives and effects of Alternative I for Sale 186.

IV.C.12.b(1)(c) Effects of Alternative I for Sale 202

Sale-specific effects from population and employment, noise and disturbance, and oil spills under Alternative I for Sale 202 for sociocultural systems generally are expected to be similar to those discussed under effects common to all alternatives.

Conclusion: Based on the sale-specific effects on subsistence resources discussed in Section IV.C.11 Subsistence-Harvest Patterns, the consequent effects on sociocultural systems under Alternative I for Sale 202 are expected to be similar to those discussed under effects common to all alternatives and effects of Alternative I for Sale 186.

IV.C.12.b(1)(d) Effects of Alternatives III, V, and VI for Sales 186 and 195

The volume of oil and the activities the would affect sociocultural systems associated with the development of that oil are essentially the same for all these alternatives, the effects on sociocultural systems are expected to be about the same as described for Alternative I for Sale 186.

Conclusion: Because effects on subsistence-harvest patterns for these Alternatives are expected to be about the same as described for Alternative I for Sale 186, subsequent effects on sociocultural systems are expected to be about the same as described for Alternative I.

IV.C.12.b(1)(e) Effects of Alternative IV for Sales 186, 195, and 202

Even though effects on subsistence resources with Alternative IV would be essentially the same as described under Alternative I for Sale 186, effects on subsistence-harvest patterns in Nuiqsut likely would be reduced, because no exploration or production activities would occur in these deferral areas, potentially reducing sources for chronic noise and disturbance effects on subsistence whaling. Effects from oil spills would not be diminished, because LA12 and P12 would not be excluded from the Oil-Spill-Risk Analysis scenario.

Conclusion: Because effects to subsistence-harvest patterns are expected to be reduced under these alternatives, subsequent effects reductions to sociocultural systems also would be expected.

IV.C.12.b(1)(f) Effects of Alternative III, V for Sale 202

Even though effects on subsistence resources with Alternatives III and V for Sale 202 would be essentially the same as described under Alternative I for Sale 202, effects on subsistence-harvest patterns in Barrow and Kaktovik are expected to be reduced, because no exploration or production activities would occur in this deferral area, potentially reducing sources for chronic noise and disturbance effects on Barrow's and Kaktovik's subsistence whaling and the western half of Kaktovik's traditional subsistence-whaling area.

Conclusion: Because effects to subsistence-harvest patterns are expected to be reduced in Barrow and Kaktovik under these alternatives, subsequent effects reductions to sociocultural systems also would be expected.

IV.C.12.b(1)(g) Effects of Alternative VI for Sale 202

Potential reductions in oil-spill contact to seals, polar bears, gray and beluga whales, caribou, muskoxen, grizzly bears, and arctic foxes from about Barter Island east to Demarcation Bay would reduce effects on these important subsistence resources and on important Kaktovik subsistence-harvest areas.

Conclusion: Because effects to subsistence-harvest patterns are expected to be reduced under this alternative, subsequent effects reductions to sociocultural systems also would be expected.

IV.C.13. Archaeological Resources

IV.C.13.a. Effects Common to All Alternatives

IV.C.13.a(1) Effects of Exploration

IV.C.13.a(1)(a) Effects from Routine Operations

IV.C.13.a(1)(a)1) Disturbances

Physical disturbance of resources could damage or destroy buildings, shipwrecks, sites, or artifacts, or cause a loss of site context with resulting loss of historical data or artifacts. Archaeological resources are nonrenewable. Archaeological surveys conducted before any activity onshore or offshore will identify potential resources, and they will be avoided or detrimental effects mitigated.

Any offshore activity that disturbs the seafloor in water depths of 2-20 meters has the potential to affect marine archaeological resources. Any activity that disturbs the seafloor in water deeper than 50 meters has the potential to affect historic resources such as shipwrecks, abandoned relics of historical importance, or airplanes. Any onshore activity that removes or disturbs soil and/or causes shallow permafrost to thaw has the potential to disturb archaeological resources. Any activity that brings development in contact with remote areas has the potential to expose archaeological resources to disturbance from construction or from vandalism.

Activities such as installation of rigs for extended-reach drilling, construction of gravel pads, year-round roads, pipeline construction and installation, gravel mining, or oil-spill-cleanup activities in the unlikely event that a large spill occurs, could damage previously unidentified onshore archaeological resources. Activities such as anchoring, pipeline trenching, excavating, emplacement of bottom-founded platforms or man-made islands, have the potential to disturb offshore archaeological resources.

Prehistoric archaeological sites could be affected by activities that disturb the surface or shallow subsurface area. Such activities include:

- Removal of conductor casing (about 1-meter in diameter), which extends from the surface down to depths of 75-100 meters, disturbs all soil inside the casing.
- Constructing a gravel pad or year-round road construction that removes soil layers or causes shallow permafrost to thaw.
- Gravel mining, particularly along the trend of paleo-riverbanks or buried over-bank deposits.
- Constructing offshore ice or gravel islands compresses Holocene sediments, releasing water and possibly biogenic gas, which could disturb the host and overlying strata. In the unlikely event that an ice-island structure fails, and sliding or shearing occurs, the seabed and shallow subsurface could be affected to depths of a few meters.

Offshore, in the unlikely event that an island is constructed directly over an archaeological resource at the seafloor, such as a historic shipwreck, the resource likely would be disturbed or destroyed. However, geophysical and archaeological surveys would identify any such resource before construction begins and the resource would be avoided or potential effects will be mitigated.

Bottom-founded structures could damage or disturb potential shallow archaeological resources, if dragging and sliding of the base-plate or skirt occurs on the seafloor when the structure is set down or removed. Penetration of the skirt could occur to a depth of approximately 2 meters.

Floating drilling platforms could disturb the sea floor and buried archaeological resources by anchor-drag during the setting of anchors or movement of the drillship or support vessels over the anchor-spread area. In addition, floating drilling platforms require the excavation of a glory hole for burying of the blowout preventor stack beneath the seafloor surface, which could affect an archaeological site.

Historic sites, such as hunting, fishing, and whaling camps, or structures associated with settlements or the Defense Early Warning system could be affected by increased human activity and construction in remote areas and the increased possibility for vandalism. Prehistoric sites, though often not as visible as historic sites, also might be subjected to increased vandalism.

IV.C.13.a(1)(a)2) Small Oil Spills

The potential effects on archaeological resources resulting from small oil spills would be from disturbance of soil and structures associated with spill-cleanup activities.

IV.C.13.a(1)(b) Effects of a Large Oil Spill

The greatest effects to onshore archaeological sites would be from cleanup activities resulting from accidental oil spills. The most important understanding from past cleanups of large oil spills is that the spilled oil usually did not directly affect archaeological resources (Bittner, 1993). The State University of New York at Binghamton evaluated the extent of petrochemical contamination of archaeological sites as a result of the *Exxon Valdez* oil spill (Dekin, 1993). Researchers concluded that the three main types of damage to archaeological deposits were oiling, vandalism, and erosion, but that fewer than 3% of the resources would suffer significant effects.

In February 2002, an agreement ensuring the protection of Alaska archaeological resources when responding to oil or hazardous-material spills was signed by representatives of the U.S. Coast Guard, U.S. Environmental Protection Agency, U.S. Department of the Interior, U.S. Department of Agriculture, Alaska Department of Natural Resources, and the Alaska Inter-Tribal Council. The agreement establishes guidelines and procedures for gathering pertinent information about archaeological sites that may be at risk in an emergency-response to a spill and institutionalizes a process for reconciling the requirements of the National Historic Preservation Act with the emergency response requirements of the Clean Water Act and the Oil Pollution Act of 1990 (www.akrrt.org/plans.shtml).

Cleanup and support activities, such as mobilizing equipment and personnel, removing soil, washing, etc., would have the greatest potential for damaging or destroying archaeological resources. Exposure of undocumented sites increases the possibility of vandalism. Increased human presence and activity increases the potential for archaeological sites to be recognized, resulting in the site having a higher chance of being vandalized. The discovery and reporting of archaeological sites during cleanup activities also would result in their being documented and protected.

Effects of an oil spill on offshore archeological resources would be minimal and limited to activities associated with oil-spill-response support vessels such as anchoring. In the unlikely event of a large offshore oil spill, effects on onshore archaeological resources could occur at sites in the Near Zone.

IV.C.13.a(2) Effects of Development and Production

IV.C.13.a(2)(a) Effects from Routine Operations

IV.C.13.a(2)(a)1) Disturbances

Any activity that removes or disturbs soil and/or causes shallow permafrost to thaw has the potential to disturb archaeological resources. Any activity that brings development to remote areas has the potential to expose archaeological resources to disturbance from construction or from vandalism.

All development drilling, constructing, and mining activities, similar to those noted for exploration, have the potential to affect prehistoric and historic archaeological resources. Development activities increase the potential for effects, because they are more frequent and occur over larger areas. In addition, development would require the construction of pipelines offshore and onshore.

The construction of a gravel island compresses Holocene sediments, releasing water and possibly biogenic gas, which could disturb the host and overlying strata, including potential prehistoric archaeological resources. Potential archaeological resources in water depths less than 20 meters where there is no indication of intense ice gouging, could be affected, if there is offshore dredging to build protective berms or for island construction.

We assume that onshore pipelines would be elevated with vertical support members (pilings) about 12 inches (30 centimeters) in diameter, which are spaced approximately 55-70 feet (17-21 meters) apart (about 90-100 beams per mile [56-62 beams/kilometer]). Each vertical beam probably would disturb less than 2 square feet (0.2 square meter) of soil to a depth of several tens of feet (tens of meters), which could penetrate soil horizons of potential archaeological significance. The potential for disturbance of archaeological resources is directly related to the distance of the development to the existing pipeline infrastructure. Any archaeological site beneath or near the pipeline right-of-way has the potential for being disturbed by the construction of roads and installation of the pipelines. Road construction has the potential to disturb archaeological sites through the removal of potential layers of concern, or by thawing of shallow permafrost. Increased human activities in the area increase the potential for vandalism.

Potential offshore archaeological resources possibly could be disturbed by pipeline trenching, vessel anchors, and installation and removal of bottom-founded drilling platforms. These types of disturbance could affect the seafloor and shallow subsurface, where archaeological resources are most likely to occur. Prehistoric archaeological resources may exist in the zone landward of the 20-meter-water depth contour line, where floating shorefast ice possibly has protected sites from destruction by ice gouging. In water depths greater than 50 meters, no prehistoric archaeological resources are expected to have existed. In water depths between the 20-meter and the 50-meter contours, ice gouging has probably severely disturbed any prehistoric archaeological sites that existed. Archaeological analysis of shallow geologic and marine geophysical survey data would identify any areas of possible archaeological resources, which would be avoided or potential effects mitigated before any activities are permitted.

IV.C.13.a(2)(a)2) Small Oil Spills

The potential effects on archaeological resources from small oil spills are the same as for the Exploration phase (Section IV.C.13.a(1)(a)2)).

IV.C.13.a(2)(b) Effects of a Large Oil Spill

The effects on archaeological resources from large oil spills would be the same as described in the section above on Exploration (Section IV.C.13.a(2)).

Conclusion. Potential effects on archaeological resources would be from exploration and development activities on both onshore and offshore resources, including historic and prehistoric. Onshore resources are more at risk for effects from disturbance caused by construction or oil-spill cleanup operations. Potential offshore resources are at greater risk for effects from bottom-disturbing activities, notably anchor dragging and pipeline trenching. Generally, potential effects from activities increase with the level of activities, from the exploration phase to the development phase. For onshore archaeological resources, the potential for effects increases with the distance from existing pipeline infrastructure and from oil-spill size and associated cleanup operations. Archaeological surveys and analyses are required in areas where potential archaeological resources are at risk from offshore operations. These requirements are specified in the MMS Handbook 620.1H, Archaeological Resource Protection; in regulations (30 CFR 250.194; 30 CFR 250.126; 30 CFR 250.201; 30 CFR 250.203; 30 CFR 250.204; 30 CFR 250.414; 30 CFR 250.1007(a)(5); and 30 CFR 250.1009); and in law through the National Historic Preservation Act. Any archaeological resources, either onshore or offshore, will be identified before any activities are permitted, and they will be avoided or potential effects will be mitigated.

IV.C.13.a(3) Number of Blocks with Archaeological Potential by Alternative

Each of the alternatives would provide some level of protection to archaeological resources by removing areas from leasing and potential exploration and development activities. The MMS has identified 502 whole or partial blocks in the program area that may contain prehistoric or historic resources (see Section III.C). The following indicates the number of blocks with archaeological potential within each alternative, their relative percent of the total number of blocks with archaeological resource potential, and the blocks with archaeological resource potential remaining in the sale area.

- Alternative III would remove 9 (1.8%) leaving 493 blocks or partial blocks
- Alternative IV would remove 17 (3.4%) leaving 485 blocks or partial blocks
- Alternative V would remove 20 (4%) leaving 482 blocks or partial blocks
- Alternative VI would remove 48 (9.6%) leaving 454 blocks or partial blocks

If these blocks or partial blocks are considered for lease, then the MMS regulations requiring archaeological surveys and analyses would apply.

IV.C.13.b. Effect of Alternatives and Sales

IV.C.13.b(1) Effects of Alternative I for Sale 186

The potential effects of disturbance of archaeological resources during the exploration phase would be the same as discussed under general effects, with activity concentrated in the Near Zone, close to existing infrastructure. Activities probably would take place during the winter with little or no permanent road or drilling-pad construction. Drilling offshore probably would be from ice islands or bottom-founded drilling units. Some drilling may take place from shore using extended-reach drilling techniques. Potential effects from oil-spill cleanup activities would be the same as discussed under general effects, limited to small releases or an unlikely blowout.

The potential for disturbance of archaeological resources during development activities would be the same as discussed for general effects, but activities would be concentrated in the Near Zone, close to existing infrastructure. Drilling and production activities probably would continue year-round. For offshore operations, manmade gravel islands probably would serve as production and drilling platforms, in which case offshore pipelines would be built. These offshore pipelines would be buried deeper than the deepest ice and current scour depths. Offshore pipelines would come ashore to existing landfalls and facilities. Some production drilling may take place from shore using extended-reach drilling techniques. Effects from oil-spill cleanup activities would be the same as discussed for general effects, increasing slightly from the exploration phase because of inherent potential for an oil spill during production activities.

Conclusion: The potential effects of Alternative I for Sale 186 on archaeological resources are essentially the same as discussed for general effects, with activity concentrated in the Near Zone, close to existing infrastructure. If extended-reach drilling techniques are used instead of offshore platforms or islands, possible offshore effects would be minimized. More potential effects could occur onshore as opposed to offshore, and in the development phase rather than the exploration phase, because of possible oil-spill-cleanup activities. Although all the projected development for Alternative I Sale 186 is in the Near and

Midrange zones where there is a higher potential for archaeological resources to occur, prehistoric and historic resources both onshore and offshore will be identified by archaeological surveys and avoided or mitigated.

IV.C.13.b(2) Effects of Alternatives IV, V, and VI for Sale 186

The exclusion of tracts in these alternatives would decrease the potential of encountering offshore prehistoric sites or shipwrecks in the deferral area and archaeological resources in adjacent onshore areas. The likely effects would be essentially the same as those discussed under effects common to all alternatives.

Conclusion: The potential effects of Alternative IV, V, and VI for Sale 186 on archaeological resources are essentially the same as discussed for effects common to all alternatives, with activity concentrated in the Near Zone, close to existing infrastructure. If extended-reach drilling techniques are used instead of offshore platforms or islands, possible offshore effects would be minimized. More potential effects could occur onshore as opposed to offshore, and in the development phase rather than the exploration phase, because of possible oil-spill-cleanup activities. Although all the projected development for Sale 186 is in the near-zone and midrange zone where there is a higher potential for archaeological resources to occur, prehistoric and historic resources both onshore and offshore will be identified by archaeological surveys and avoided or mitigated.

IV.C.13.b(3) Effects of Alternatives I, IV, V, and VI for Sale 195

Activities in Alternatives I, IV, V, and VI for Sale 195 probably would occur farther from the main infrastructure of existing fields. Activities in the Midrange Zone would involve some exploration farther offshore from existing infrastructure, in combination with nearshore and possible extended-reach drilling from onshore, in areas farther away from existing infrastructure. Potential effects on resources are likely to be the same as discussed under effects common to all alternatives, with activities ranging into areas father away from existing infrastructure and in deeper water. For the exploration phase, this means that more drilling could occur offshore, slightly increasing the possibility of encountering possible archaeological resources, with less potential effect on onshore resources.

Potential effects from disturbance of archaeological resources during development activities would be the same as discussed under effects common to all alternatives, but activities would take place in the Midrange Zone, farther away from existing infrastructure. Drilling and production activities probably would continue year-round. For offshore operations, manmade gravel islands or bottom-founded structures probably would serve as production and drilling platforms, which means that offshore pipelines would be necessary. These offshore pipelines would be buried deeper than the deepest ice and current scour depths. Offshore pipelines would come ashore and connect with existing infrastructure via onshore pipelines. Some production drilling may take place from shore using extended-reach drilling techniques. Onshore pipelines would have to be built, which would require construction along the pipeline right-of-way.

Conclusion: The effect of exploration and development activities on possible archaeological resources would be essentially the same as discussed under effects common to all alternatives, except that activities may be farther away from existing onshore infrastructure. Exploration activities probably would be conducted from offshore facilities, which would reduce the potential impact on onshore archaeological resources. Marine archaeological surveys in areas where offshore archaeological resources may exist would identify likely resources that would be avoided or effects mitigated. In the development phase, the potential for effects to archaeological resources increases with distance from existing infrastructure, primarily because of onshore pipeline distances and associated construction and right-of-way access and the increased possibility for oil-spill-cleanup activities. Onshore archaeological surveys would identify any potential resources, which will be avoided or possible effects mitigated.

IV.C.13.b(4) Effects of Alternatives I, IV, V, and VI for Sale 202

Activities in Alternatives I, IV, V, and VI for Sale 202 are envisioned to be the farthest from the existing infrastructure. Activities in the Far Zone would involve exploration in relatively deeper water and in more remote locations. Potential effects on resources likely would be the same as discussed for effects common to all alternatives, with activities ranging into areas farther away from existing infrastructure. For the exploration phase, this means that more drilling could occur offshore, increasing the possibility of encountering possible archaeological resources while excavating the glory hole that shields the blowout-preventer stack. Potential effects from oil-spill-cleanup activities would be the same as discussed for effects common to all alternatives, except that spills, even an unlikely large spill, from offshore drilling farther from shore may pose less of a threat for oil reaching the coast.

The effects from disturbance of archaeological resources during development activities would be the same as discussed under effects common to all alternatives, but activities would be in the Far Zone, farther away from existing infrastructure and possibly in deeper water. If activities take place in water depths greater than 50 meters, there probably would be no effect on prehistoric archaeological resources. According to relative sea level data for the Beaufort Sea, areas of the shelf deeper than 50 meters would have been below sea level at 13,000 Before Present when prehistoric human populations may have been in the area. Drilling and production activities probably would be conducted year-round. For offshore operations, floating platforms, ships, or bottom-founded facilities probably would serve as production and drilling platforms. These offshore facilities may use subsea production systems and blowout preventors buried beneath the seafloor. Offshore pipelines would be built and would be unburied in deepwater and buried deeper than the deepest ice and current scour depths in shallower water. Onshore pipelines would have to be built, which would require construction along the right-of-way. Potential effects on archaeological resources of oil spills would be the same as discussed for effects common to all alternatives. Where production is from deeper water, there possibly may be less onshore pipeline infrastructure, and cleanup activities associated with a spill would be limited to the shoreline. Where production is from shallow water, pipelines likely would need a new landfall and shore crossing and could require construction of a new processing facility and shore base. The new construction associated with these activities increase the chance of encountering prehistoric and historic resources. New onshore pipelines inherently increase the possibility of a spill and associated cleanup activities.

Conclusion: The effect of exploration and development activities on possible archaeological resources would be essentially the same as discussed under effects common to all alternatives, except that activities would be more dispersed. In the exploration phase, some drilling could take place in deeper water, using floating drilling platforms or ships. These drilling units would use anchors and would probably have their blowout preventor buried, which could disturb potential archaeological resources in the immediate area. No impact is expected to prehistoric archaeological resources from activities in water depths greater than 50 meters. In the development phase, floating drilling and production platforms and possibly subsea production well-head assemblies would have the same disturbance effect to the seafloor as in the exploration phase: anchor dragging and digging the glory hole. The effect of gravel islands or bottom-founded production systems would be the same as discussed under effects common to all alternatives, compression and skirt penetration of sediments. The effect of oil-spill cleanup activities depend on the size of the spill and would probably be limited to the Near Zone, but the response area would be larger and more difficult for response personnel to access, potentially exposing unknown archaeological resources to risk of damage. Onshore and offshore archeological surveys and analyses would be conducted and would identify potential archaeological resources, which will be avoided or possible effects would be mitigated.

IV.C.13.b(5) Effects of Alternative III for Sales 186, 195, and 202

Alternative III for Sales 186, 195, and 202 would reduce the potential for effects on prehistoric or historic resources in the deferral areas. The potential for encountering shipwrecks during offshore operations would be greatly reduced because of the high potential for possible shipwrecks to occur in the general area offshore Barrow. There would less potential disturbance in the adjacent land areas, which otherwise might have experienced construction activities related to pipeline infrastructure or a staging area.

Conclusion. Alternative III for Sales 186, 195, and 202 would reduce the potential for effects on prehistoric or historic resources in the deferral areas. The potential for encountering shipwrecks during offshore operations would be greatly reduced because of the high potential for possible shipwrecks to occur in the general area offshore Barrow. There would less potential disturbance in the adjacent land areas, which otherwise might have experienced construction activities related to pipeline infrastructure or a staging area.

IV.C.14. Land Use Plans and Coastal Management Programs

All of the alternatives, except Alternative II No Lease Sale, for each of the proposed sales (186, 195, and 202) assume the same amount of oil and, for purposes of land use planning and review with Coastal Management Programs, the levels of activity between alternatives and sales are very similar. Therefore, the effects to land use plans and coastal management plans are essentially the same. The analysis that follows focuses on the effects to the plans and programs and it does not follow the format used by the other resources evaluated in this section.

The analysis that follows is common to all alternatives and sales.

Onshore activities and some offshore activities resulting from OCS oil and gas lease sales will be subject to the North Slope Borough Comprehensive Plan and Land Management Regulations and the Alaska Coastal Management Program (ACMP), as amended by the North Slope Borough Coastal Management Plan (NSB CMP). The North Slope Borough's Land Management Regulations are applied to all developments occurring on private and State lands. These developments include portions of road/pipeline corridors, including offshore portions within the North Slope Borough boundary. All development that occurs within the coastal management boundaries identified in the approved NSB CMP or affects uses or resources of the coastal zone, including activities described in Exploration Plans and Development and Production Plans, will be subject to the Statewide standards and North Slope Borough district policies of the ACMP. The policies of the Land Management Regulations and the ACMP are examined for potential conflicts with the potential effects identified in Sections IV.C.1 through IV.C.12.

Development on the coastal plain of the Arctic National Wildlife Refuge has not been authorized by Congress. No pipeline routes are assumed to traverse the Refuge; no conflict with Refuge policy is inherent in the scenarios.

IV.C.14.a. North Slope Borough Comprehensive Plan and Land Management Regulations

During exploration, most onshore support would be based in existing facilities in the Prudhoe Bay area. Any permits that are requested probably would be conditional-use permits for specific temporary activities; these are permissible in the Conservation District. The more permanent development associated with production would require that a master plan be prepared describing anticipated activities. Use of non-Federal land may require rezoning from the Conservation District to the Resource Development District or Transportation Corridor.

Areawide policies in the revised Land Management Regulations are the same as those for the NSB CMP policies. The primary difference would be the process used for implementation and the geographic areas covered. The Land Management Regulations have been applied to all lands within the North Slope Borough that are not in Federal ownership. Policies in the ACMP cover only activities within the coastal zone but can be applied to Federal lands in many instances (see Section IV.C.13(b)). Therefore, development assumed to occur following a lease sale usually would be subject both to the Land Management Regulations areawide policies and the ACMP policies. To avoid a redundant analysis, potential conflicts with the Land Management Regulations areawide policies are included with the NSB CMP policies in the analysis of the ACMP rather than here.

Policies considered in this section are those in the other Land Management Regulation policy categories: Villages, Economic Development, Offshore Development, and Transportation Corridors. Potential conflict with these policies is limited to some extent by the locations assumed for the development that accompanies a lease sale.

No development is anticipated to occur within village boundaries; therefore, the four policies directly related to developing within North Slope Borough communities would not be applicable.

Economic Development policies afford special consideration for projects during land use reviews that have features the North Slope Borough considers beneficial impacts (NSBMC [NSB Municipal Code]

19.70.030(A) through (G). Economic Development policies foster hiring practices favorable to North Slope Borough businesses and residents, including special work schedules for those who pursue subsistence activities, and generate excess tax revenues over demand for expenditures.

Offshore Development policies are intended to guide the approval of development and uses in the portion of the Beaufort Sea within the North Slope Borough. Policy 19.70.040.E is the only one of these that applies to activities other than drilling. This policy requires that "(a)ll nonessential boat, barge and air traffic associated with drilling activity…occur prior to or after the period of whale migration through the area." Moreover, essential traffic is required to avoid disrupting the migration and subsistence activities and be coordinated with the Alaska Eskimo Whaling Commission. This policy will be especially applicable during development.

The last category of policies covers the Transportation Corridor. New offshore pipelines will be routed to connect to existing onshore pipelines using existing landfalls when it is feasible. It is assumed that if additional pipeline corridors are built, (1) the area would become zoned as a Transportation Corridor, and (2) these policies would apply as the pipeline crossed land subject to North Slope Borough Land Management Regulations. Developers would be held responsible for minimizing airport use, ensuring proper sand and gravel extraction and reclamation, buffering stream banks, locating away from active floodplains, avoiding sensitive habitats, and identifying and documenting archaeological sites prior to construction (NSBMC 19.70.060.C, D, E, F, G, H, I, and J, respectively).

In conducting reviews for other development projects in the North Slope Borough that have some features comparable to those for the pipeline corridors, the North Slope Borough has established special conditions to ensure conformance with several land use policies. Policy areas of concern in the past related to deposition of toxic materials and untreated solid wastes, emissions, subsistence resources, sensitive areas, pollution, habitat changes and disturbance, and permafrost.

IV.C.14.b. Alaska Coastal Management Program

Section 307(c)(3)(B) of the Federal Coastal Zone Management Act, as amended, requires lessees to certify that each activity that is described in detail in the lessee's exploration and development and production plans that affects any land use or water use in the coastal zone complies with, and will be implemented consistent with, the State's coastal program. The State has the responsibility to concur with or object to the lessees' certification. Activities that could occur within the coastal zone include pipeline landfalls, offshore pipelines within 3 miles of the coast, and transportation facilities. In addition, the State reviews all OCS exploration and development and production plans to certify that activities that affect any land or water use or natural resource of the coastal zone are consistent with the ACMP.

This analysis is not a consistency determination pursuant to the Coastal Zone Management Act nor should it be used as a local planning document. It is highly unlikely that all the events that are hypothesized will occur as assumed in this EIS. The leasing of tracts does not mean that exploration will occur or that commercial discoveries will be made on these tracts. Most tracts leased are never explored and most discoveries are too small to support commercial development. Leasing in the Beaufort Sea OCS began in 1979. A total of 688 Federal leases were issued as a result of the 7 sales; only 54 leases remain. Thirty exploration wells have been drilled as a result of those sales; those wells have been plugged and abandoned. Two leases are part of a production unit (Northstar). Only 4% of all leases issued to date have been explored. In addition, changes made by lessees if they explore, develop, or produce petroleum products could affect the accuracy of this analysis.

Lessees must certify that each activity that is described in detail in an Exploration or Development and Production Plan that affects any land use, water use, or coastal resource within the coastal zone complies with, and will be implemented consistent with, the State's coastal program. The State will review OCS plans and concur or object with the lessee's consistency certification. The MMS cannot issue a permit for any activities described in the plans in the absence of the State's concurrence unless the Secretary of Commerce overrides the State's objection.

In the following paragraphs the standards of the ACMP are related to the hypothetical scenarios developed for this EIS and to the potential for effects as identified in other sections of this EIS. Policies of the NSB

CMP are assessed in conjunction with the most closely associated Statewide standard. As noted in Section IV.C.13.a, the NSB CMP policies have been incorporated into the Land Management Regulations. Therefore, the corresponding Land Management Regulation policy number is listed following that of the NSB CMP policy.

IV.C.14.b(1) Coastal Development (6 AAC 80.040)

Water dependency is a prime criterion for development along the shoreline (6 AAC 80.040 [a]). The intent of this policy is to ensure that onshore developments and activities that can be placed inland do not displace activities dependent upon shoreline locations. The only OCS developments or activities hypothesized in the scenarios that require a shoreline location are landfall sites for pipelines.

State standards also require that the placement of structures and discharges of dredged material into coastal waters comply with the regulations of the U.S. Army Corps of Engineers (6 AAC 80.040 [b]). All offshore and much of the onshore development hypothesized in the scenarios would be subject to Corps of Engineers regulations. Hypothetical developments along the Beaufort Sea coast that would require Corps of Engineers permits include constructing a berm for shoreline approaches for pipelines, dredging for and possibly burying offshore pipelines, and placing pipelines and any associated roads onshore. None of these projects necessarily is allowed or disallowed under the provisions of the Corps of Engineers regulations. Site-specific environmental changes pursuant to such development would be assessed and permitted depending on the attendant effects.

It is unlikely that the hypothetical development scenarios will conflict with this coastal development policy.

IV.C.14.b(2) Geophysical Hazard Areas (6 AAC 80.050)

This Statewide standard requires coastal districts and State agencies to identify areas in which geophysical hazards are known and in which there is a substantial probability that geophysical hazards may occur. Development in these areas is prohibited until siting, design, and construction measures have been provided for minimizing property damage and protecting against the loss of life. The following discussion addresses activities inside and outside the coastal zone.

Several hazards are evident in area. Sea ice is the principal physical hazard in the development of oil and gas resources in the Beaufort Sea. However, drilling and completing wells in the Arctic is possible with existing technology (Section IV.A.6). In the EIS, permafrost, storm surges, faults and earthquakes, hydrates and shallow gases, and factors affecting the geotechnical characteristics of the seafloor sediments are related specifically to offshore activities. The summary in Section IV.A.6 identifies three measures that can be taken to lessen the effects of these hazards. These include scheduling activities appropriately, conducting surveys for best locations, and designing facilities to withstand a range of environmental forces. Through these strategies and conformance with the MMS regulations of 30 CFR 250, Oil and Gas and Sulphur Operations in the OCS, hazards can be effectively addressed.

The MMS regulations, including the platform verification program, regulate lessees to ensure that geophysical hazards, such as those identified, are accommodated in the exploration and development and production plans that must be approved before lessees may commence activities. Conformance with these regulations also should alleviate conflict that could occur with respect to two NSB CMP policies. Policy 2.4.4(b) (NSBMC 19.70.050. I.2) requires that “offshore structures must be able to withstand geophysical hazards and forces which may occur while at the drill site.” These structures also “must have monitoring programs and safety systems capable of securing wells in case unexpected geophysical hazards or forces are encountered.” Policy 2.4.4(h) (NSBMC 19.70.050.I.8) requires that “Offshore oil transport systems (for example, pipelines) must be specially designed to withstand geophysical hazards, specifically sea ice.”

Any onshore development and some offshore development will be sited in areas of permafrost. Development in these areas must “maintain the natural permafrost insulation quality of existing soils and vegetation” (NSB CMP 2.4.6(c) and NSBMC 19.70.050.L.3). Some of the onshore development (for example, pipelines) may be located in wetlands, in floodplains subject to a 50-year recurrence level, and in geologic-hazard areas identified on Map 22 of the NSB CMP Resource Atlas. These last two areas are specifically identified in the NSB CMP policies (NSB CMP 2.4.5.1(k) and NSBMC 19.70.050.J.11). For developments to proceed in these areas, there would have to be a significant public need, no feasible and prudent alternatives, and all feasible and prudent steps taken to avoid the adverse effects the policy is intended to prevent. A final requirement is that development in floodplains, shoreline areas, and offshore areas be "sited, designed, and constructed to minimize loss of life or property" due to geologic forces (NSB CMP 2.4.6[f] and NSBMC 19.70.050.L.6). Safeguards offered by these policies are enforced at the time an activity or project is proposed and locational information is available.

There are no inherent conflicts with the Statewide standard or with the North Slope Borough policies related to geophysical hazards.

IV.C.14.b(3) Energy Facilities (6 AAC 80.070)

The State CMP requires that decisions on the siting and approval of energy-related facilities be based, to the extent feasible and prudent, on 16 standards. The following discussion addresses only those that are applicable to the scenarios presented in this EIS.

The ACMP standards require that facilities be sited to (1) minimize adverse environmental and social effects while satisfying industrial requirements and (2) be compatible with existing and subsequent uses (6 AAC 80.070 (1) and (2)). Any pipeline landfalls along the Beaufort Sea coast are expected to tie into existing nearby production lines and to use the existing support infrastructures located at Kuparuk and Prudhoe Bay. A landfall hypothesized at Point Thomson would use infrastructure planned for development in the Point Thomson area. Flaxman Island, commonly used by subsistence hunters for their base camp, is offshore of the landfall. It is likely that construction activities would occur during the whaling season. However, disturbance from these construction activities would be temporary and conducted in a manner that would minimize or eliminate any disturbance.

Other ACMP standards require that facilities be consolidated and sited in areas of least biological productivity, diversity, and vulnerability (6 AAC 80.070 (3)). The NSB CMP also requires that "transportation facilities and utilities must be consolidated to the maximum extent possible" (NSB CMP 2.4.5.2(f) and NSBMC 19.70.050. K.6). Onshore activities hypothesized for OCS oil and gas activities are, with the possible exception of one additional landfall site, consolidated at existing sites where pipelines come onshore. Existing facilities can accommodate the support services, thereby conforming with another standard (6 AAC 80.070 (7)). These locational decisions conform to NSB CMP policy 2.4.5.2(c) (NSBMC 19.70.050.K.3) that requires facilities not absolutely required in the field be located in designated compact service bases that are shared to the maximum extent possible.

Facilities must be designed to permit free passage and movement of fish and wildlife with due consideration for historic migratory patterns (6 AAC 80.070 (12), NSB CMP 2.4.4 (I), and NSBMC 19.70.050.I.9). As is evidenced by the Endicott development, this standard does not preclude causeways or berms, but it does require careful consideration of the effects on circulation and fish populations before approval can be obtained. The short length of shore-approach berms or causeways may result in localized, short-term effects on the movement and migration of fish populations (Section IV.C.3). Offshore pipelines should pose no barriers to migrating fish and wildlife. Conflict is not anticipated.

Finally, the Statewide standard requires that facilities be sited "so as to minimize the probability, along shipping routes, of spills or other forms of contamination which affect fishing grounds, spawning grounds, and other biologically productive or vulnerable habitats..." (6 AAC 80.070 [b][11]). Landfall sites will conform with this requirement. For example, oil spills pose the greatest threat of all possible effect agents; however, the analysis in Section IV.C indicates that these sites do not accentuate the potential for adverse effects in the unlikely event of an oil spill.

The NSB CMP has two additional requirements associated with this standard. Policy 2.4.4(f) (NSBMC 19.70.050.I.6) requires that plans for offshore drilling include "a relief well drilling plan and an emergency countermeasure plan" and describes the content of such plans. Policy 2.4.4(g) (NSBMC 19.70.050.I.7) requires "offshore drilling operations and offshore petroleum storage and transportation facilities...have an oilspill control and clean-up plan" and describes what the plan should contain. Conformance with these policies is ensured through the implementation of MMS regulations in 30 CFR 250 Subpart B - Exploration and Development and Production Plans and 30 CFR 254 - Oil-Spill Response Requirements for Facilities Located Seaward of the Coastline.

No conflicts with the Statewide standards or with the North Slope Borough policies related to the siting and approval of energy related facilities are anticipated.

Construction associated with energy-related facilities resulting from sales also must comply with siting standards that apply to all types of development. These more general standards are discussed under (g) Habitats and (h) Air, Land, and Water Quality.

IV.C.14.b(4) Transportation and Utilities (6 AAC 80.080)

This Statewide standard requires that routes for transportation and utilities be compatible with district programs and sited inland from shorelines and beaches. Assuming that after an offshore pipeline crossed the beach it would continue inland of the beaches, conformance with this policy is possible.

The NSB CMP contains several additional policies related to transportation that are relevant to this analysis. All but one of the policies are "best-effort policies" and subject to some flexibility if (1) there is a significant public need for the proposed use and activity; (2) the development has rigorously explored and objectively evaluated all feasible and prudent alternatives to the proposed use or activity and cannot comply with the policy; and (3) all feasible and prudent steps have been taken to avoid the adverse effects the policy was intended to prevent. "Transportation development, including pipelines, which significantly obstructs wildlife migration" is subject to these three criteria (NSB CMP 2.4.5.1(f) and NSBMC 19.70.050.J.7). Section IV.C.8 indicates that interference with wildlife movement and distribution would be temporary and brief; caribou migrations and overall distribution are not expected to be affected.

As noted in the previous standard for energy facilities, transportation facilities are expected to be consolidated to the maximum extent possible. Therefore, there should be no conflict with either NSB CMP 2.4.5.1(h) (NSBMC 19.70.050.J.9), which discourages duplicative transportation corridors from resource-extraction sites, or NSB CMP 2.4.5.2(f) (NSBMC 19.70.050.K.6), which requires that transportation facilities and utilities be consolidated to the maximum extent possible. Although the NSB CMP limits support facilities for tankering oil to market, the scenario indicates that pipelines will be used; therefore, the policy is not relevant.

The final policy falls under the category of "Minimization of Negative Impacts." NSB CMP 2.4.6(b) (NSBMC 19.70.050.L.2) requires that alterations to shorelines, water courses, wetlands, and tidal marshes and significant disturbance to important habitat be minimized. In the discussion of habitats, it is recognized that alterations to wetland habitat and ponds and lakes could occur, and birds could be disturbed during construction. This policy also requires that periods critical for fish migration be avoided. However, it is anticipated that development will be able to proceed in accordance with this policy by conforming to the requirements for siting, design, construction, and maintenance of the facilities.

The NSB CMP 2.4.6(e) requires a means of providing for unimpeded wildlife crossing to be included in the design and construction of structures such as roads and pipelines that are located in areas used by wildlife. Pipeline design must be based on the best available information and include adequate pipeline elevation, ramping, or burial to minimize disruptions of migratory patterns and other major movements of wildlife. Aboveground pipelines must be elevated a minimum of 5 feet from the ground to the bottom of the pipe, except at those points where the pipeline intersects a road, pad, or caribou ramp, or is constructed within 100 feet of an existing pipeline that is elevated less than 5 feet. It is anticipated that development will be able to proceed in accordance with this policy by conforming to requirements stated in the policy. No conflicts are anticipated with this Statewide standard or the North Slope Borough policies related to Transportation and Utilities.

IV.C.14.b(5) Mining and Mineral Processing (6 AAC 80.110)

Extraction of sand and gravel is a major concern on the North Slope. Gravel resources are needed for construction pads for all onshore development to protect the tundra, including roadbeds, berms or causeways, and docks. The ACMP Statewide standards require that mining and mineral processing be compatible with the other standards, adjacent uses and activities, State and national needs, and district programs (6 AAC 80.110 (a)). Sand and gravel may be extracted from coastal waters, intertidal areas, barrier islands, and spits when no feasible and prudent noncoastal alternative is available to meet the public need (6 AAC 80.110 (b)). Substantial alteration of shoreline dynamics is prohibited (NSB CMP 2.4.5.1(i) and NSBMC 19.70.050.J.10). Constraints may be placed on extraction activities to lessen environmental degradation of coastal lands and waters and to ensure floodplain integrity (NSB CMP 2.4.5.2(a) and (d) and NSBMC 19.70.050.K.1 and 4).

Although industry's preferences for gravel sources and removal procedures and the Statewide standards and NSB CMP policies may diverge on occasion from those that are deemed consistent, it is anticipated that sand and gravel extraction activities will be conducted consistent with the policies related to mining and mineral processing. Conflict is not inherent in the hypothesized scenarios.

IV.C.14.b(6) Subsistence (6 AAC 80.120)

The Statewide standard for subsistence guarantees opportunities for subsistence use of coastal areas and resources. Subsistence uses of coastal resources and maintenance of the subsistence way of life are primary concerns of the residents of the North Slope Borough.

North Slope Borough Policy 2.4.3(d) (NSBMC 19.70.050.D) requires that development not preclude reasonable subsistence-user access to a subsistence resource.

Several important NSB CMP policies relate to adverse effects to subsistence resources. The NSB CMP policy 2.4.3(a) (NSBMC 19.70.050.A) relates to "extensive adverse impacts to a subsistence resource" that "are likely and cannot be avoided or mitigated." In such an instance, "development shall not deplete subsistence resources below the subsistence needs of local residents of the Borough." Policy 2.4.5.1(a) (NSBMC 19.70.050.J.1) relates to "development that will likely result in significantly decreased productivity of subsistence resources or their ecosystems."

Disturbance and noise resulting from the hypothesized post-lease activities periodically could affect subsistence resources, but no resource would become unavailable and no resource population would experience an overall decrease. Disturbances and noise could occur as a result of disturbance from seismic surveys, aircraft and vessel traffic, drilling activities, and construction activities that include onshore construction such as pipeline, road, support-base, landfall, and pump-station construction; and offshore dredging; pipeline construction; and structure placement. These effects are expected to be local, nonlethal, and temporary.

Accidental small oil spills periodically could affect subsistence resources. In the unlikely event of a large accidental spill during development and production, some harvest areas and some subsistence resources could become unavailable for use until such time as resources and harvest areas were perceived as safe by local subsistence hunters. The duration of avoidance by subsistence users would vary depending on the amount of oil spilled, the persistence of oil in the environment, the degree of impact on the resources, the time necessary for recovery and the confidence in assurances that resources were safe to eat. The potential for bowhead whales to be contacted directly from an oil spill is small, but the potential chance of contact to whale habitat, whale-migration corridors, and subsistence-whaling areas is relatively greater. Onshore areas and terrestrial subsistence resources have a lower potential for oil-spill contact to the species and the habitat. Such effects are not expected from routine activities and operations, but could occur in the unlikely event of an accidental large spill.

Oil-spill-cleanup activity related to a large spill would increase noise and disturbance effects to all subsistence species; could result in the displacement of subsistence species; and could alter or reduce access to subsistence species by subsistence hunters, thereby having the potential to temporarily alter or extend normal subsistence hunts.

North Slope Borough policy 2.4.3(a) relates to "extensive adverse impacts to a subsistence resource" that "are **likely** and cannot be avoided or mitigated." Policy 2.4.5.1(a) relates to "development that will **likely** result in significantly decreased productivity of subsistence resources or their ecosystems." The policies address "likely" events. A large spill is an unlikely event.

No conflicts with this Statewide standard or with the North Slope Borough policies related to subsistence are anticipated. However, in the unlikely event of a large oil spill and associated oil-spill-cleanup activities some resource populations could suffer losses and, as a result of tainting, bowhead whales could be rendered unavailable for use until they were perceived as safe by subsistence users.

Caribou could be disturbed temporarily during construction of pipelines and roads but are expected to habituate to the traffic following construction (Section IV.C.7). This conclusion is based partially on the established policy that roads and pipelines are constructed to provide for unimpeded wildlife crossings. The NSB CMP policy 2.4.6(e) (NSBMC 19.70.050.L.5) emphasizes this practice and provides a set of guidelines and an intent statement specifically to implement the policy.

Standard mitigating measures included as part of the proposed sales (186, 195, and 202) address subsistence harvesting activities. They include the stipulations on the Industry Site-Specific Bowhead Whale-Monitoring Program and the Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvesting Activities. The Information to Lessees clause on the Availability of Bowhead Whales for Subsistence-Hunting Activities advises lessees that MMS may limit or require that operations be modified if they could result in significant effects on the availability of the bowhead whale for subsistence use.

IV.C.14.b(7) Habitats (6 AAC 80.130)

The Statewide standard for habitats contains an overall standard policy plus policies specific to eight habitat areas: offshore areas; estuaries; wetlands and tideflats; rocky islands and sea cliffs; barrier islands and lagoons; exposed high-energy coasts; rivers, streams, and lakes; and important upland habitat (6 AAC 80.130 (a), (b), and (c)). Activities and uses that do not conform to the standards may be permitted if there is significant public need and no feasible prudent alternatives to meet that need, and all feasible and prudent measures are incorporated to maximize conformance (6 AAC 80.030 (d)). The NSB CMP contains a district policy that reiterates the applicability of the Statewide standard (NSB CMP 2.4.5.2(g) and NSBMC 19.70.050.K.7), plus several others that augment the overall policy or can be related to activities within a specific habitat.

The ACMP Statewide standard for all habitats in the coastal zone requires that habitats "be managed so as to maintain or enhance the biological, physical, and chemical characteristics of the habitat which contribute to its capacity to support living resources" (6 AAC 80.130 (b)). This overall policy is supported by an NSB CMP district policy requiring development "to be located, designed, and maintained in a manner that prevents significant adverse impacts on fish and wildlife and their habitat, including water circulation and drainage patterns and coastal processes" (NSB CMP 2.4.5.2(b)] and NSBMC 19.70.050.K.2). In addition, "vehicles, vessels, and aircraft that are likely to cause significant disturbance must avoid areas where species that are sensitive to noise or movement are concentrated at times when such species are concentrated" (NSB CMP 2.4.4 [a] and NSBMC 19.70.050.I.1). Some disturbances associated with exploration and development would be mitigated by the Stipulation on Protection of Biological Resources and the ITL clauses concerning Bird and Marine Mammal Protection and Areas of Biological and Cultural Sensitivity (Section II.E). The analyses in Sections IV.C.2 through 7 indicate that resources would not be subject to significant disturbance from these activities. If they are, however, the policy requires that, consistent with human safety, horizontal and vertical buffers will be required where appropriate. Although there are no inherent conflicts with the assumed activities at this point, some may appear as specific exploration or development proposals are brought forward. It is anticipated that the concerns related to this policy can be effectively addressed at that time.

Activities may affect several of the habitats identified in the Statewide standard, including offshore; barrier islands and lagoons; wetlands; and rivers, lakes, and streams. Potential effects in each habitat are related to the applicable policies in the following paragraphs.

The offshore habitat is designated a fisheries conservation zone (6 AAC 80.130. (c)(1)). In the Arctic, marine mammals are an important offshore resource and are included in the analysis of the offshore habitat. Some effects in the offshore habitat can be expected in the unlikely event that an oil spill occurred in a sensitive area, or in specific coastal areas during critical periods for several fishes. Effects identified in Sections IV.C.2 through IV.6 would not preclude offshore development, assuming the developer has undertaken all feasible and prudent steps to maximize conformance. Offshore seismic exploration is subject to specific constraints; NSB CMP 2.4.6(g) (NSBMC 19.70.050.L.7) requires that seismic exploration be conducted in a manner that minimizes its impact on fish and wildlife. Several mitigating measures address concerns related to these habitat policies: the stipulation of Protection of Biological

Resources; and the ITL clauses on Bird and Marine Mammal Protection, River Deltas, and Sensitive Areas to be Considered in Oil-Spill-Contingency Plans.

It is anticipated that seismic exploration can proceed in conformance with this policy.

Barrier islands and lagoons characterize the Beaufort Sea coast where some of the development associated with OCS oil and gas leasing is assumed to occur (NSB CMP Map 16). These habitats are managed to ensure sediment and water conditions are maintained so neither infilling of lagoons nor erosion of barrier islands occurs. Activities that might decrease the use of the barrier islands by coastal species, including polar bears and nesting birds, are discouraged (6 AAC 80.130 (c)(5)). Although disruptive activities could occur in this habitat during the laying of pipelines and construction of landfall sites, effects of offshore construction on birds and marine mammals, potential effects on abundance and distribution of a population or portion of a population would be localized and would last for only a short period of time. Consequently, no conflict with this habitat policy is anticipated.

Much of the uplands in the North Slope Borough are considered wetlands. Because any development of wetlands might affect navigable waters, development of any kind on those wetlands necessarily falls under the oversight of the U.S. Army Corps of Engineers. Therefore, onshore development would need to be designed and constructed to avoid (1) adverse effects to the natural drainage patterns, (2) destruction of important habitat, and (3) the discharge of toxic substances (6 AAC 80.130 (c)(3)). Pipelines and roadways would transect this habitat both to the east and to a very limited extent to the west of the Trans-Alaska Pipeline. Water impoundments created by pipeline/road corridors would carry both positive and negative effects. They would benefit some waterfowl but displace some nesting shorebirds in localized areas near a pipeline-road complex (Section IV.C.5).

It is expected that any onshore development will proceed in keeping with this wetland policy; no conflicts are anticipated.

Restrictions on storing toxic substances are covered more completely by policies related to the following topics: air, land, and water quality.

Rivers, lakes, and streams are managed to protect natural vegetation, water quality, important fish or wildlife habitat, and natural water flow (6 AAC 80.130 [c][7]). The probability of an oil spill occurring and contacting the nearshore waters of the river deltas is small. However, pipeline/road construction, including gravel extraction, also could affect these waterways and would need to be conducted to ensure the protection of riverine habitat and fish resources. Gravel extraction also is regulated under policies that are described in the section on mining. Activities occurring as a result of OCS oil and gas lease sales are anticipated to be in compliance with this policy, and conflicts are not expected.

No conflicts are anticipated with the Statewide standard or with the North Slope Borough policies related to Habitats.

IV.C.14.b(8) Air, Land, and Water Quality (6 AAC 80.140)

The air-, land, and water-quality standard of the ACMP incorporates by reference all the statutes pertaining to, and regulations and procedures of, the Alaska Department of Environmental Conservation in effect on August 18, 1992. The North Slope Borough reiterates this standard in its district policies and emphasizes the need to comply with specific water- and air-quality regulations in several additional policies.

The agents associated with petroleum exploitation that are most likely to affect water quality are hydrocarbons from oil spills; trace metals in permitted discharges of drilling muds and cuttings; and turbidity from permitted dredging, filling and other construction activities. No oil spills are assumed to occur during exploration activities. In the unlikely event of an accidental spill for the development and production phase, the Oil-Spill-Risk Analysis model, for purposes of analysis, uses a 1,500-barrel spill from a platform or a 4,600-barrel spill from a pipeline. Hydrocarbons from small accidental spills could result in local hydrocarbon contamination; and hydrocarbons from a large oil spill could exceed the 1.5-parts per million-acute toxic criterion during the first several days of a spill and the 0.015-ppm-chronic criterion for about a month in an area of about 400 square kilometers. Other effects of postlease-sale activities would not affect regional water quality. The increased turbidity from permitted construction activities such as dredging would be local and short term. Trace metals from permitted discharges of drilling muds and cuttings over the life of the field could exceed sublethal levels but over only a few square kilometers

As a precaution against accidental spills, the NSB CMP requires the use of impermeable lining and diking for fuel-storage units with a capacity greater than 660 gallons (NSB CMP 2.4.4(k) and NSBMC 19.70.050.I.11). In addition, development within 1,500 feet of the coast, a lakeshore, or river "that has the potential of adversely impacting water quality (for example, landfills, or hazardous-materials storage areas, dumps, etc.)" must comply with the conditions of the best-effort policies (NSB CMP 2.4.5.1(d) and NSBMC 19.70.050.J.4). These conditions are: (1) there is a significant public need, (2) the development has rigorously explored and objectively evaluated all feasible and prudent alternatives and cannot comply with the policy, and (3) all feasible and prudent steps have been taken to avoid the adverse effects the policy was intended to prevent.

Some discharges and emissions would occur during exploration and development, and the NSB CMP policy 2.4.4(c) (NSBMC 19.70.050.I.3) requires that "development resulting in water or airborne emissions ...comply with all state and federal regulations." Discharges of muds, cuttings, and drilling fluids are regulated closely. Given the rate of discharge, changes in water quality during exploratory drilling would be local and temporary (only during active discharges) and remain within an area of 0.03 square kilometers. During development, effects from muds and cuttings would be local and short term. Formation waters produced from the wells along with the oil are regulated through an Environmental Protection Agency permit and, depending on the conditions of the permit, may be disposed of above or below ground. To date, for exploration in the Beaufort Sea, the Environmental Protection Agency has prohibited discharge of formation waters into waters less than 10 meters deep; reinjection and injection projects have been the standard. If formation waters were discharged in the water, the effect on water quality would be local and would be regulated by an Environmental Protection Agency National Pollution Discharge Elimination System permit. If formation waters were reinjected or injected into a different formation, as is expected, no discharge of formation waters would occur and no effect would occur. Recent offshore developments (for example, Endicott and Northstar) have reinjected such wastes rather than discharging them.

Offshore disposal of solid wastes also is regulated through Federal permits and restrained further by Annex V of the MARPOL Convention approved in 1988 by the United States Congress. Because these discharges are so carefully regulated, no conflict is anticipated with the Statewide standard or NSB CMP policy 2.4.4(d) (NSBMC 19.70.050.I.4), which requires that "industrial and commercial development…be served by solid waste disposal facilities which meet state and federal regulations." Onshore development associated with this sale also must meet the Statewide standard and the district policy related to solid-waste disposal. Assuming the regulations are implemented properly, there is no inherent conflict between the proposed activities and the ACMP water-quality provisions.

The district CMP also contains a policy that requires development without a central sewage system to impound and process effluent to meet State and Federal standards (NSB CMP 2.4.4(e) and NSBMC 19.70.050.I.5). This is the current practice aboard drilling vessels and production platforms; there is no inherent conflict with this district policy. This also has been the practice of the major developments on the North Slope.

Sand and gravel may be extracted from coastal waters, intertidal areas, barrier islands, and spits when no feasible and prudent noncoastal alternative is available to meet the public need (6AAC 80.110 (a)). Solid-fill islands may be constructed and used for shallow-water development. Island construction could be completed within one to two summers, and effects on water quality would be short term and local, lasting only while the activity persisted (Section IV.C.1). Air quality also must conform to Federal and State standards (6 AAC 80.140, NSB CMP 2.4.3(I) and 2.4.4(c), and NSBMC 19.70.050.H and I.3). The analysis in Section IV.C.15 indicates that conformance is anticipated, and no conflict between air quality and coastal policies should occur.

The most likely agents to affect water quality are hydrocarbons from oil spills, trace metals in discharges of drilling muds and cuttings, and turbidity from dredging, filling and other construction activities. No spills are assumed to occur during exploration activities. In the unlikely event of a large accidental spill during development and production, hydrocarbons could exceed the acute toxic criterion during the first several days and the chronic criterion for about a month in an area about 400 square kilometers.

Hydrocarbons from small accidental spills could result in local hydrocarbon contamination for a short time period. Effects from the remaining affects agents would also be local and short term. Discharges into the marine environmental are subject to permits issued by the Environmental Protection Agency and are not expected to exceed State standards in the coastal zone or have an effect on coastal resources. In addition, the Federal regulations at 30 CFR Part 250 Oil and Gas and Sulphur Operations in the Outer Continental Shelf and Part 254 Oil-Spill Response Requirements for Facilities Located Seaward of the Coast Line provide for MMS oversight and regulatory authority over these activities.

No conflicts are anticipated with the Statewide standard or with the North Slope Borough policies related to Air, Land, and Water Quality.

IV.C.14.b(9) Statewide Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150)

The ACMP Statewide standard requires that coastal districts and appropriate State agencies identify areas of the coast that are important to the study, understanding, or illustration of national, State, or local history or prehistory.

The North Slope Borough developed additional policies to ensure protection of its heritage. The NSB CMP 2.4.3(e) (NSBMC 19.70.050.E) requires that development that is "likely to disturb cultural or historic sites listed on the National Register of Historic Places; sites eligible for inclusion in the National Register; or sites identified as important to the study, understanding, or illustration of national, state, or local history or prehistory shall (1) be required to avoid the sites; or (2) be required to consult with appropriate local, state and federal agencies and survey and excavate the site prior to disturbance." The NSB CMP 2.4.3(g) (NSBMC 19.70.050.G) goes on to require that "development shall not cause surface disturbance of newly discovered historic or cultural sites prior to archaeological investigation." These NSB CMP policies establish clearly what is required. In the unlikely event such a site is encountered, there is no inherent reason to assume conflict with these policies.

Traditional activities at cultural or historic sites also are protected under the NSB CMP 2.4.3(f) (NSBMC 19.70.050.F) and 2.4.5.2(h) (NSBMC 19.70.050.K.8). As noted in the discussion of policies related to subsistence, the latter is a best-effort policy that requires protection for transportation to subsistence-use areas as well as cultural-use sites.

The MMS regulations at 30 CFR 250.194 require archaeological reports in exploration and development and production plans when it is likely that an archaeological resource exists in the area. If a resource may be present the lessee must comply with specific regulatory requirements to protect the resource. If the lessee discovers any archaeological resource while conducting operations they must immediately halt operations within the area of the discovery and report the discovery to the MMS.

No conflicts with the policies related to Historic, Prehistoric, and Archaeological Resources are anticipated.

Effectiveness of Mitigating Measures: Mitigating measures are assumed to be in place for this analysis; effects levels reflect this assumption. Mitigation that would apply to subsistence-harvest activities includes the Orientation Program stipulation, the Industry Site-Specific Bowhead Whale-Monitoring Program stipulation, and the stipulation on Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvesting Activities.

The Orientation Program stipulation requires the lessee to conduct a program that educates personnel working on exploration or development and production activities about the environmental, social, and cultural concerns that relate to the area and area communities. The program is expected to increase personnel sensitivity and understanding of local Native community values, customs, and lifestyles and to prevent any conflicts with subsistence activities.

The Industry Site-Specific Bowhead Whale-Monitoring Program stipulation requires industry to conduct a whale monitoring program if exploratory drilling or seismic activity is conducted during the bowhead whale migration to assess the behavioral effects on bowheads from these activities. The monitoring plan is subject to the review of the North Slope Borough and the Alaska Eskimo Whaling Commission, invites both Borough and the Commission representatives to serve as observers, and requires the plan be independently peer reviewed. This stipulation provides site specific information about the migration of bowhead whales and any affects that may occur as a result of oil and gas activities. This stipulation helps reduce effects to subsistence-harvest activities by providing immediate information to lessees about the activities of the whales and their response to specific events. This information can be used to determine whether and to whale extent activities may be affecting subsistence activities.

The stipulation on Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvesting Activities requires industry to conduct operations in a manner that prevents unreasonable conflict with subsistence activities, especially the bowhead whale hunt. Prior to submitting a plan, the lessee must consult with potentially affected subsistence communities of Barrow, Nuiqsut, and Kaktovik; the North Slope Borough; and the Alaska Eskimo Whaling Commission about the operations proposed to ensure that they minimize any potential siting and timing conflicts with subsistence whaling and other subsistence-harvest activities. When an operations plan is submitted to the MMS, the Alaska Eskimo Whaling Commission will participate in a concurrent review of the plan. If conflicts between industry and subsistence whalers arise over planned exploration or development and production activities, any of the affected parties can request that MMS convene a conflict-resolution panel composed of members from industry, the subsistence communities, the North Slope Borough, the Alaska Eskimo Whaling Commission, and the National Marine Fisheries Service. Only after this group has convened will MMS make a final decision on the adequacy of measures taken to prevent unreasonable conflicts to subsistence-hunting activities. Lease-related use will be restricted if it is determined necessary to prevent such conflicts with subsistence hunting. Subsistence whalers and industry have established a history for negotiating agreements that work for both parties.

In addition, the ITL clause on the Availability of Bowhead Whales for Subsistence-Hunting Activities advises lessees that MMS may limit or require that operations be modified if they could result in significant effects on the availability of the bowhead whale for subsistence use. The Orientation Program, Industry Site-Specific Bowhead Whale-Monitoring Program, Conflict Avoidance stipulations, and the ITL on the Availability of Bowhead Whales for Subsistence-Hunting Activities will serve collectively to mitigate disturbance effects on Native lifestyles and subsistence practices.

Proposed stipulations on Permanent Facility Siting in the Vicinity Seaward of Cross Island, Permanent Facility Siting in the Vicinity Shoreward of Cross Island, and Pre-booming Requirements for Fuel Transfers are not expected to decrease the potential for conflict with the enforceable policies of the ACMP and the NSB CMP. The intent of the proposed stipulations on permanent facility siting in the vicinity of Cross Island is met by the stipulation on Conflict Avoidance.

Summary: Conflicts with the Statewide standards of the ACMP and the NSB CMP policies are not expected. Through the use of mitigating measures and regulatory oversight, it should be possible to comply with all of the standards and policies. Most of these policies will be more precisely addressed if and when specific proposals are brought forward by lessees. All Exploration and Development and Production plans must be accompanied by a consistency certification for State review and concurrence. The State will review OCS plans and concur or object with the lessee's consistency certification. MMS cannot issue a permit for any activities described in the plans in the absence of the State's concurrence unless the Secretary of Commerce overrides the State's objection. The NSB CMP policy 2.4.3(a) relates to "extensive adverse impacts to a subsistence resource" that "are likely and cannot be avoided or mitigated." Paragraph (d) of the same policy requires that development not preclude reasonable subsistence-user access to subsistence resources. Policy 2.4.5.1(a) relates to "development that will likely result in significantly decreased productivity of subsistence resources or their ecosystems." These policies address "likely" events. Although a large oil spill is not a "likely" event, for analysis purposes the EIS examines a hypothetical large spill and its potential consequences. In the unlikely event of a large oil spill during development and production, some resource populations could suffer losses and, as a result of tainting, bowhead whales could be rendered unavailable for use. The duration would vary depending on the volume of the spill, the persistence of oil in the environment, degree of impact on resources, the time necessary for recovery, and the confidence in assurances that resources were safe to eat. In the unlikely event of a large spill, impacts to subsistence resources and subsistence-user access could occur. However, this would be an accidental event and is considered unlikely.

Conclusion: No conflicts with the Statewide standards of the ACMP or with the enforceable policies of the NSB CMP are anticipated.

IV.C.14.c. Effects by Alternatives and Sales

Alternatives I, III, IV, V, and VI for Sales 186, 195, and 202. The potential for conflict with the Statewide standards of the ACMP and the enforceable policies of the NSB CMP are the same for all alternatives and sales – no conflicts are anticipated. Although each of the alternatives would defer portions of the proposed sale areas, activity outside the deferral areas would still be subject to the ACMP standards and NSB CMP enforceable policies. Activities described in all exploration and development and production plans must be reviewed for consistency with the enforceable policies of the ACMP and NSB CMP.

Conclusion: No conflicts with the Statewide standards of the ACMP or with the enforceable policies of the NSB CMP are anticipated.

IV.C.15. Air Quality

IV.C.15.a. Introduction

This discussion analyzes the potential impacts on air quality that could be caused by the activities and developments induced by Alternatives I, III, IV, V, and VI for Sales 186, 195, and 202. Impacts to air quality would result from discharges (air emissions). Because disturbances and noise do not cause air quality impacts, they will not be discussed further. Supporting materials and discussions are presented in Section III.A.6 (description of existing air quality in the Beaufort Sea). Mitigation of adverse air quality impacts would result from operators' use of the best available technology to control discharges. None of the standard or proposed stipulations and ITL clauses is particularly applicable to air quality impacts.

Air pollutants discussed include nitrogen oxides, carbon monoxide, sulfur dioxide, particulate matter, and volatile organic compounds. Ozone is not emitted directly by any source but is formed in a series of complex photochemical reactions in the atmosphere involving volatile organic compounds and nitrogen oxide.

Nitrogen oxides consist of both nitric oxide and nitrogen dioxide. Nitrogen oxide is formed from the oxygen and nitrogen in the air during combustion processes, and the rate of the formation increases with combustion temperature. Nitric oxide, the major component of the combustion process, will slowly oxidize in the atmosphere to form nitrogen dioxide; nitrogen dioxide and volatile organic compounds perform a vital role in the formation of photochemical smog. Nitrogen dioxide breaks down under the influence of sunlight, producing nitric oxide and atomic oxygen, which then combine with diatomic oxygen to form ozone or with volatile organic compounds to form various gaseous and particulate compounds that result in the physiological irritation and reduced visibility typically associated with photochemical smog.

Carbon monoxide is formed by incomplete combustion. It is a problem mainly in areas having a high concentration of vehicular traffic. High concentrations of carbon monoxide present a serious threat to human health, because they greatly reduce the capacity of the blood to carry oxygen.

Sulfur dioxide is formed in the combustion of fuels containing sulfur. In the atmosphere, sulfur dioxide slowly converts to sulfate particles. Sulfates in the presence of fog or clouds may produce sulfuric-acid mist. It generally is recognized that entrainment of sulfur oxides or sulfate particles into storm clouds is a major contributor to the reduced pH levels observed in acid-rain precipitation.

Emissions of particulate matter associated with combustion consist of particles in the size range less than 10 microns in diameter (PM_{10}). Emissions of particulate matter associated with combustion, especially particles in the size range of 1-2 microns, can cause adverse health effects. Particulates in the atmosphere also tend to reduce visibility.

The type and relative amounts of air pollutants generated by offshore operations vary according to the phase of activity. There are three principal phases: exploration, development, and production. For a more detailed discussion of emission sources associated with each phase, refer *to Air Quality Impact of Proposed*

OCS Lease Sale No. 95 (Jacobs Engineering Group, Inc., 1989). Significant emission sources are summarized below.

Federal and State statutes and regulations define air quality standards in terms of maximum allowable concentrations of specific pollutants for various averaging periods (see Table III.A.5). These maxima are designed to protect human health and welfare. However, one exceedance per year is allowed, except for standards based on an annual averaging period. The standards also include Prevention of Significant Deterioration (PSD) provisions for nitrogen dioxide, sulfur dioxide, and PM_{10} to limit deterioration of existing air quality that is better than that otherwise allowed by the standards (an attainment area). Maximum allowable increases in concentrations above a baseline level are specified for each PSD pollutant. There are three classes (I, II, and III) of PSD areas. Class I allows the least degradation and also restricts degradation of visibility. The areas adjacent to the sale area are Class II, which allows a moderate incremental decrease in the air quality of the area. Baseline PSD pollutant concentrations and the portion of the PSD increments already consumed are established for each location by the Environmental Protection Agency and the State of Alaska before issuance of air quality permits. Air quality standards do not directly address all other potential effects, such as acidification of precipitation and freshwater bodies or effects on nonagronomic plant species.

With the enactment of the Clean Air Act Amendments of 1990, the Environmental Protection Agency has jurisdiction for air quality over this Beaufort Sea program area. The lease operators must comply with that agency's requirements for OCS sources, including the provisions of Title I, Part C, of the Clean Air Act (Prevention of Significant Deterioration of Air Quality). Section 328 states that for a source located within 25 miles of the seaward boundary of a State, requirements would be the same as those that would apply if the source were located in the corresponding onshore area.

IV.C.15.b. Effects Common to All Alternatives

IV.C.15.b(1) Discharges (Air Emissions)

IV.C.15.b(1)(a) Exploration Phase

For the exploration phase, emissions would be produced by (1) vessels used in gathering seismic and other geological and geophysical data; (2) diesel power-generating equipment needed for drilling exploratory and delineation wells; (3) tugboats, supply boats, icebreakers, and crew boats in support of drilling activities; and (4) intermittent operations such as mud degassing and well testing. Pollutants generated would primarily consist of nitrogen oxide (these would consist of nitric oxide and nitrogen dioxide; ambient air standards are set only for nitrogen dioxide), carbon monoxide, and sulfur dioxide. For each of the three sales, we assume that exploration activity would begin in the year following that sale. Emissions from exploration would be from seismic surveys and from drilling one to two exploration wells and two to four delineation wells from one rig at each discovery (one to three per sale). Drilling would continue at a rate of one or two exploration wells each year thereafter. Please see the Exploration and Development Scenarios in Appendix F to this EIS for more details.

IV.C.15.b(1)(b) Development and Production Phase

For the development phase, including temporary construction operations and drilling, the main sources of emission offshore would be the following:

- gas turbines used to provide power for drilling;
- reciprocating engines for electrical power, including rig generator (during construction phase only; standby only during commissioning);
- heavy construction equipment used to install facility and pipelines (including gravel-hauling dump trucks);
- construction and commissioning support equipment, including cranes, pumps, generators, compressors, pile drivers, welders, heaters, and flare;

- tugboats (needed to move equipment and supply barges) and support vessels; and
- drill-rig-support equipment, including boilers and heaters.

For all these operations, the best available control technology would be applied under the Environmental Protection Agency's air quality regulations. The main emissions would be nitrogen oxides, with lesser amounts of sulfur dioxide, carbon monoxide, and particulate matter. Once in the atmosphere, nitric oxide gradually converts to nitrogen dioxide.

For the production phase, the main source of offshore emissions would be from turbines for power generation and gas compression, and from power generation for oil pumping and water injection. The emissions would consist mainly of nitrogen oxides, with smaller amounts of carbon monoxide and particulate matter. Another source of emissions would be evaporative losses (volatile organic compounds) from oil/water separators, from pump and compressor seals and valve packing; using seal systems designed to reduce emissions would minimize these sources. Produced water and slop-oil tanks would be equipped with a vapor-recovery system, which would recover emissions of volatile organic compounds from these tanks and return them to the process. Operators would probably have a flare available 24 hours a day, 365 days a year. If there were venting (unexpected), it would emit volatile organic compounds. However, flaring largely would burn up any emissions of volatile organic compounds, and they should not create a pollution problem. Flaring mostly would produce some nitrogen oxides, sulfur dioxide, particulate matter, and carbon monoxide. Venting or flaring would probably produce only a very small amount of sulfur dioxide, because we expect that sulfur in the produced gas should be very low (but never completely absent).

Abandonment of facilities developed after the proposed sales would cause much higher vehicular traffic by trucks and barges, and also more heavy equipment operations than during the production phase of operations, but effects probably would be quite similar to the construction portion of the development phase of operations. Because abandonment operations would last perhaps a maximum of 10-15% of total operations time and would include no activities that should affect air quality more significantly than previously discussed, we conclude that these operations would cause insignificant effects on air quality.

Other sources of pollutants related to outer continental shelf operations are accidents such as blowouts and oil spills. Typical emissions from such accidents consist of hydrocarbons (volatile organic compounds); only fires associated with blowouts or oil spills produce other pollutants.

Emissions from development under Alternative I for Sale 186 would be from the installation of a maximum of three platforms and 40 miles of pipeline, and the drilling of a maximum of 69 production wells and 33 injection wells. In the peak years, a probable maximum of 20 wells per year would be drilled from two rigs. Peak-year production emissions would result from operations producing about 43.8 million barrels of oil and from transportation of that oil. See Appendix F Exploration and Development Scenarios, and Table F-2 for more details of the expected infrastructure.

The proposal for Sale 144 was, to some extent, roughly comparable in area with the area of Alternative I for Sales 186, 195, and 202 being analyzed in this current EIS, although the assumed level of development for each individual Beaufort Sea sale is lower than that associated with Sale 144. The projected production for each lease sale is 460 million barrels, compared with 1,200 million barrels for Sale 144. The peak production rate is 43.8 million barrels per year, compared with 101 million barrels per year for Sale 144. The number of platforms installed is two or three, while eight platforms were projected for Sale 144. Thus, the impacts from a Beaufort Sea sale likely would be somewhat lower than the impacts predicted from the analysis for Sale 144. Additional information and discussion from the EIS for Sale 144 (USDOI, MMS, 1996a) provides some details relevant to the current analysis. Table IV.B.12-1 of the Sale 144 final EIS lists estimated uncontrolled-pollutant emissions for the peak-exploration, peak-development, and peak-production years from that sale proposal. That EIS also has additional relevant discussion, especially in the last paragraph of Section IV.B.12.(1). Modeling discussed there shows that nitrogen dioxide had the highest concentration of the modeled pollutants, but that all pollutant contributions would be well within the PSD increments and Federal ambient air quality standards.

We refer also to the air quality analyses performed for the Northstar and Liberty projects. These projects would be typical of development in the Near Zone (about half of the projects assumed for Sales 186, 195, and 202). The projected peak production rate per platform in the current Alternative I for Sale 186 is

40,000-60,000 barrels per day, which is comparable to the 65,000 barrels per day that was assumed for the Northstar and Liberty development projects. For Liberty, the highest predicted concentrations for nitrogen dioxide, sulfur dioxide, and PM_{10} occurred just outside the facility boundary and were close to the PSD Class II maximum allowable increments. The highest onshore concentrations would be considerably less because of their dispersion over distance. The combined facility concentrations plus background were well within the ambient air quality standards (between 2 and 30% of the standards).

Because Alternative I for Sale 186 being analyzed in this EIS should have impacts that are lower than those predicted for Sale 144 and similar to those predicted for Northstar or Liberty, we conclude that for Alternative I for Sale 186, the expected pollutant contributions also would be well within PSD increments and Federal ambient air quality standards.

IV.C.15.b(2) Oil Spills

IV.C.15.b(2)(a) Details on How an Oil Spill May Affect Air Quality

Based on modeling work by Hanna and Drivas (1993), the volatile organic compounds from offshore facility or pipeline oil spills likely would evaporate almost completely within a few hours after the spill occurred. The article cited discusses the rate or evaporation and ambient concentrations of 15 different volatile organic compounds. Several of these compounds, such as benzene, ethylbenzene, toluene, and n-xylenes, are classified by the Environmental Protection Agency as hazardous air pollutants. The study results showed that these compounds evaporate almost completely within a few hours after the spill occurs. Ambient concentrations peak within the first several hours after the spill starts and are reduced by two orders of magnitude after about 12 hours. The heavier compounds take longer to evaporate and may not peak until about 24 hours after spill occurrence. Total ambient concentrations of volatile organic compounds are significant in the immediate vicinity of an oil spill, but concentrations are much reduced after the first day. If there were a continuing release of oil, the volatile organic compounds obviously would be released over the longer period of time during which the spilled oil itself was being released. These volatile emissions could impede response to the spill, depending on the type of release, wind speed and direction, and other incident-specific factors.

Diesel fuel oil could be spilled either while being transported or from accidents involving vehicles, vessels, or equipment. A diesel spill would evaporate faster than a crude oil spill. Ambient hydrocarbon concentrations would be higher than with a crude oil spill but also would persist for only a shorter time. Also, because any such spill probably would be smaller than some potential crude oil spills, any air quality effects from a diesel spill likely would be even lower than for other spills.

Oil or gas blowouts may catch fire. In addition, in situ burning is a preferred technique for cleanup and disposal of spilled oil. Burning could affect air quality in two important ways. For a gas blowout, burning would reduce emissions of gaseous hydrocarbons by 99.98% and very slightly increase emissions of other pollutants. If an oil spill were ignited immediately after spillage, the burn could combust 33-67% of crude oil or higher amounts of fuel oil (diesel) that otherwise would evaporate. On the other hand, incomplete combustion of oil would inject about 10% of the burned crude oil as oily soot, plus minor quantities of other pollutants, into the air. In situ burning would be less effective in areas of broken ice than in open water, but it still would reduce the effects of volatile organic compounds on the ambient air quality.

IV.C.15.b(2)(b) Effects of Oil-Spill Cleanup Activities on Air Quality

In situ burning as part of a cleanup of spilled crude oil or diesel fuel would temporarily adversely affect air quality, but the effects would be low. For much greater detail, please see the article by Fingas et al. (1995). Extensive ambient measurements were performed during two experiments involving the in situ burning of approximately 300 barrels of crude oil at sea. During the burn, carbon monoxide, sulfur dioxide, and nitrogen dioxide were measured only at background levels and frequently were below detection levels. Ambient levels of volatile organic compounds were high within about 100 meters of the fire, but were significantly lower than those associated with a nonburning spill. Measured concentrations of polyaromatic hydrocarbons were found to be low, as it appeared that a major portion of these compounds were consumed in the burn. Effects of in situ burning for spilled diesel fuel would be similar to those associated with a crude oil spill.

Over the life of oil exploration and development and production in the sale area, an oil spill could be set on fire accidentally or deliberately. Potential contamination of the shore would be limited, because exploration and development and production activities under Alternative I for Sales 186, 195, and 202 would be at least 4.8 kilometers (3 miles) offshore, with the exception of any oil- or gas-transport pipelines. Also, large fires create their own local circulating winds, toward the fire at ground level, that affect plume motion. Accidental emissions likely would have a minimal effect on onshore air quality.

If an oil spill were ignited immediately after spillage, the burn could combust 33-67% of the crude oil or higher amounts of fuel oil that otherwise would evaporate. On the other hand, incomplete combustion of oil would inject about 10% of the burned crude oil as oily soot, and minor quantities of other pollutants, into the air (see USDOI, MMS, 1996a:Table IV.B.12-4).

Additional work published in an article by McGrattan et al. (1995) reported that smoke-plume models have shown that the surface concentrations of particulate matter does not exceed the health criterion of 150 micrograms per cubic meter beyond about 5 kilometers downwind of an in situ burn. This is quite conservative, as this health standard is based on a 24-hour average concentration rather than a 1-hour average concentration. This appears to be supported by field experiments conducted off of Newfoundland and in Alaska (McGrattan et al., 1995).

Other air quality effects from cleanup activities would include emissions from vessels, vehicles, and equipment used in the cleanup effort; these should be very low.

Summary and Conclusion for Effects of an Oil Spill on Air Quality. In the unlikely event of a large oil spill from an offshore facility or pipeline, such a spill could cause a small, local increase in the concentrations of gaseous hydrocarbons (volatile organic compounds) due to evaporation from the spill. The concentrations of volatile organic compounds concentrations would be very low and normally be limited to only 1 or 2 square kilometers (0.4-0.8 square miles). During open-water conditions, spreading of the spilled oil and action by winds, waves, and currents would disperse the volatile organic compounds, so that they would be at extremely low levels (although over a relatively larger area). During broken-ice or melting-ice conditions, because of limited dispersion of the oil, the concentrations might reach slightly higher levels for several hours, possibly up to 1 day. The effects from a spill occurring under the ice would be similar to but less than those described for broken-ice or melting-ice conditions; the oil would be trapped and essentially remain unchanged until the ice began to melt and breakup occurred. Some of the volatile organic compounds, however, would be released from the oil and dispersed, even from under the ice. In any of these situations, moderate or greater winds further would reduce the concentrations of volatile organic compounds in the air. Concentrations of criteria pollutants would remain well within Federal air quality standards. The overall effects on air quality would be minimal.

IV.C.15.b(3) Effects of Accidental Emissions

Sources of air pollutants related to OCS operations include accidental emissions resulting from gas or oil blowouts. The number of blowouts on the U.S. OCS, almost entirely gas and/or water, averaged 3.3 per 1,000 wells drilled from 1956 through 1982 (Fleury, 1983). Danenberger (1993) determined a frequency of 4.1 blowouts per 1,000 wells drilled from 1971 through 1991. Typical emissions from such accidents consist of hydrocarbons (volatile organic compounds); only fires associated with blowouts produce other pollutants, such as nitrogen oxides, carbon monoxide, sulfur dioxide, and particulate matter. Accidental emissions likely would have little effect on onshore air quality.

A gas blowout could release 20 tons per day of gaseous hydrocarbons, of which about 2 tons per day would be nonmethane hydrocarbons classified as volatile organic compounds. The probability of experiencing one or more blowouts in drilling the wells projected for Alternative I for Sales 186, 195, and 202 is estimated to be low. If a gas blowout did occur, it would be unlikely to persist more than 1 day; and it very likely would release less than 2 tons of volatile organic compounds. Since 1974, 60% of the blowouts have lasted less than 1 day; and only 10% have lasted more than 7 days.

Gas or oil blowouts may catch fire. In addition, in situ burning is a preferred technique for cleanup and disposal of spilled oil in oil-spill-contingency plans. For catastrophic oil blowouts, in situ burning may be the only effective technique for spill control. Please see Section IV.A.6.b for a discussion of in situ burning.

Burning could affect air quality in two important ways. For a gas blowout, burning would reduce emissions of gaseous hydrocarbons by 99.98% and very slightly increase emissions—relative to quantities in other oil and gas industrial operations—of other pollutants (see USDOI, MMS, 1996a:Table IV.B.12-3). For a major oil blowout, setting fire to the wellhead could burn 85% of the oil, with 5% remaining as residue or droplets in the smoke plume in addition to the 10% soot injection (Evans et al., 1987). Clouds of black smoke from a burning 360,000-barrel oil spill 75 kilometers off the coast of Africa locally deposited oily residue in a rainfall 50-80 kilometers inland. Later the same day, clean rain washed away most of the residue and allayed fears of permanent damage.

Based on qualitative information, burns that are two or three orders of magnitude smaller do not appear to cause noticeable fallout problems. Along the Trans-Alaska Pipeline, 500 barrels of a spill were burned over a 2-hour period, apparently without long-lasting effects (Schulze et al., 1982). The smaller volume Tier II burns at Prudhoe Bay had no visible fallout downwind of the burn pit (Industry Task Group, 1983).

Soot is the major contributor to pollution from a fire. This soot, which would cling to plants near the fire, would tend to slump and wash off vegetation in subsequent rains, limiting any health effects. Coating portions of the ecosystem in oily residue is the major, but not the only, potential air quality risk. Recent examination of polycyclic aromatic hydrocarbons in crude oil and smoke from burning crude oil indicates that the overall amounts of polycyclic aromatic hydrocarbons change little during combustion, but the kinds of compounds of polycyclic aromatic hydrocarbons present do change. Benzo(a)pyrene, which often is used as an indicator of the presence of carcinogenic varieties of polycyclic aromatic hydrocarbons, is present in crude-oil smoke in quantities approximately three times larger than in the unburned oil; however, only in very small amounts (Evans, 1988). Investigators have found that, overall, the oily residue in smoke plumes from crude oil is mutagenic but not highly so (Sheppard and Georghiou, 1981; Evans et al., 1987). The Expert Committee of the World Health Organization considers daily average smoke concentrations of greater than 250 micrograms per cubic meter to be a health hazard for bronchitis.

Because of the distance from shore (at least 4.8 kilometers, or 3 miles) and the dispersal of airborne pollutants by winds, accidental emissions likely would have a minimal effect on onshore air quality.

IV.C.15.b(4) Other Effects on Air Quality

Other effects of air pollution from OCS activities and other sources on the environment not specifically addressed by air-quality standards include the possibility of damage to vegetation, acidification of coastal areas, and atmospheric visibility impacts. Effects may be short term (hours, days, or weeks), long term (seasons or years), regional (Arctic Slope), or local (nearshore only). Visibility may be defined in terms of visual range and contrast between plume and background (which determines perceptibility of the plume). For their proposed Liberty Project, BPXA had run the VISCREEN model and found noticeable effects on only a very limited number of days, ones that had the most restrictive meteorological conditions. No effects at all were simulated during average conditions. We expect that those results would be typical of other development projects that could occur after any discoveries following the currently proposed lease sales.

A significant increase in ozone concentrations onshore is not likely to result from exploration, development, or production scenarios associated with any of the proposed sales (186, 195, and 202). Photochemical pollutants such as ozone are not emitted directly; they form in the air from the interaction of other pollutants in the presence of sunshine and heat. Although sunshine is present in the Beaufort Sea Planning Area most of each day during the summer, temperatures remain relatively low (Brower et al., 1988). Also, activities occurring as a result of field development are offshore and separated from each other, diminishing the combined effects from these activities and greatly increasing atmospheric dispersion of pollutants before they reach shore. At a number of air-monitoring sites in the Prudhoe Bay and Kuparuk areas, ozone measurements show that the highest 1-hour-maximum ozone concentrations generally are in the range of 0.05-0.07 parts per million, which is well within the existing maximum 1-hour-average ozone standard of 0.12 parts per million. The highest 8-hour average ozone concentration is always somewhat lower than the maximum 1-hour average. Therefore, ozone levels are expected to be within the revised 8-hour average ozone standard of 0.08 parts per million. (**Note:** The 8-hour Federal ozone standard currently is under litigation. The Environmental Protection Agency cannot enforce the standard until the legal issues are resolved.) Because the projected ozone precursor emissions from any of the proposed sales (186, 195, and 202) are considerably lower than the existing emissions from the Prudhoe Bay and Kuparuk oil fields, the proposed sales (186, 195, and 202) should not cause any ozone concentrations to exceed the 8-hour Federal standard.

Olson (1982) reviewed susceptibility of fruticose lichen, an important component of the coastal tundra ecosystem, to sulfurous pollutants. There is evidence that sulfur dioxide concentrations as low as 12.0 micrograms per cubic meter for short periods of time can depress photosynthesis in several lichen species, with damage occurring at 60 micrograms per cubic meters. In addition, the sensitivity of lichen to sulfate is increased in the presence of humidity or moisture, conditions that are common on coastal tundra. However, because of the small size and number of sources of sulfur dioxide emissions, the ambient concentrations at most locations may be assumed to be near the lower limits of detectability. Because of the distance of the proposed activities from shore, attendant atmospheric dispersion, and low existing levels of onshore pollutant concentrations, the effect on vegetation under Alternative I for Sales 186, 195, and 202 is expected to be minimal. For their proposed Liberty development project, BPXA had found that maximum modeled pollutant concentrations were well below levels that can damage lichens, according to laboratory studies. This likely would also apply to other development projects that could follow the currently proposed lease sales. Research at Prudhoe Bay from 1989 through 1994 showed no effects of pollutants there on vascular plants or lichens (Kohut et al., 1994). That research was conducted in areas typical of much of the Beaufort Sea Planning Area. Monitoring the vascular and lichen plant communities over the 6 years revealed no changes in species composition that could be related to differences in exposures to pollutants.

IV.C.15.b(5) Nuiqsut's Views on Air Emissions

Elder Bessie Ericklook from Nuiqsut maintained that since the oil fields have been established at Prudhoe Bay, the foxes have been dirty and discolored in the area of Oliktok Point (Ericklook, 1979, as cited in USDOI, Bureau of Land Management, 1979a). Leonard Lampe, then Mayor of Nuiqsut, more recently reported further air-pollution problems and habitat concerns, asserting that Nuiqsut has been experiencing such effects for some time: "A lot of air pollution, asthma, bronchitis—a lot with young children. We see smog pollution that goes from Prudhoe Bay out to the ocean and sometimes to Barrow when the wind is blowing that way..." (Lavrakas, 1996:1, 5). Because of the distances from the most likely developments to Nuiqsut and the relatively small sizes of these projects in comparison with the Prudhoe Bay complex, the proposed sales (186, 195, and 202) would have no significant effect with respect to these observations.

Summary and Conclusion for Effects on Air Quality. Effects on onshore air quality from air emissions likely would be only a very small percent of the maximum allowable Prevention of Significant Deterioration Class II increments. The concentrations of criteria pollutants in the onshore ambient air would remain well within the air-quality standards. Consequently, there likely would be only a minimal effect on air quality with respect to standards. Principally, because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore due to exploration and development and production activities or accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from oil fires.

The air-quality analysis is based on the specific emission controls and emission limitations that the operators would apply to meet the appropriate Environmental Protection Agency regulations and permit requirements for any development and production activities. The effects of all these activities would cause only small, local, temporary increases in the concentrations of criteria pollutants. Concentrations would be within the Prevention of Significant Deterioration Class II limits and National Ambient Air Quality Standards. Therefore, effects from the proposed sales would be low.

IV.C.15.c. Effects of Alternatives and Sales

Air quality impacts are determined by atmospheric transport and dispersion patterns and the relative locations of the emission sources and receptors (points where impacts are evaluated). These characteristics will vary to some extent in different locations within the Beaufort Sea. Wind patterns are determined by large-scale circulation systems as well as by local topography and heat exchange between the atmosphere, ocean, and ice. Atmospheric dispersion patterns are very complex as well. The air quality modeling for Sale 144, Northstar, and Liberty used meteorological data from just a few stations, which generally are not representative of the whole Beaufort Sea area. Results for a similar project, such as the Alternative I for Sale 186, are likely to vary from one area to another, depending on local meteorological and topographical conditions. The air quality modeling for the projects mentioned are based on the best available information for the Beaufort Sea; they can be thought of as providing a best "first guess" of conditions anywhere in the proposed sale area. Because the predicted impacts are small, it can be reasonably assumed that the effects from facilities anywhere in the region would fall within the regulatory standards.

Because individual air masses move constantly with atmospheric circulation, we expect that the major differences in effects of the different alternatives upon air quality would be in which specific geographic areas could be affected by air emissions. Because these emissions should not be significant other than in extremely localized areas, we conclude that none of the alternatives to the proposed sales (186, 195, and 202) would result in significant effects different from or other than those discussed in Section IV.C.15.a. Air quality effects of all activities under all sales and all alternatives would cause only small increases in the concentrations of criteria pollutants. Concentrations would be within the PSD Class II limits and National Ambient Air Quality Standards. Therefore, effects from Alternative I for Sales 186, 195, and 202 would be low.

IV.C.15.c(1) Effects of Alternative I for Sale 186

This action would have the highest potential for impacts to shore, because it has the largest number of development projects in the Near Zone. Potentially affected areas primarily would be locations on the North Slope where current oil development is taking place.

IV.C.15.c(2) Effects of Alternative I for Sale 195

Alternative I for Sale 195 would have relatively lower potential impacts than Alternative I for Sale 186, because the level of activity is shifted more into the Midrange Zone, where distances generally are greater. However, areas to the west (around Harrison Bay) and to the east (a portion of the Arctic National Wildlife Refuge) may experience higher impacts than from Sale 186.

IV.C.15.c(3) Effects of Alternative I for Sale 202

Alternative I for Sale 202 would have lower potential for impacts than Alternative I for Sales 186 and 195, because all of the projected activities would occur in the Far Zone. However, this sale could result in the highest impacts occurring in areas off the National Petroleum Reserve-Alaska and the Arctic National Wildlife Refuge.

IV.C.15.c(4) Effects of Alternatives III, IV, V, and VI for Sales 186, 195 and 202 and Alternatives III and IV for Sale 202

These deferrals would reduce the potential impacts to the adjacent onshore areas.

IV.C.15.c(5) Effects of Alternative V for Sale 202

This alternative would eliminate potential air quality impacts to a portion of the Arctic National Wildlife Refuge.

IV.C.15.c(6) Effects of Alternative VI for Sale 202

This alternative would eliminate potential air quality impacts to a portion of the Arctic National Wildlife Refuge.

IV.C.16. Environmental Justice

IV.C.16.a. Introduction

Alaska Inupiat Natives, a recognized minority, are the predominant residents of the North Slope Borough, the area potentially most affected by the Beaufort Sea multiple sales. Effects on Inupiat Natives could occur because of their reliance on subsistence foods, and exploration and development may affect subsistence resources and harvest practices. Potential effects could be experienced by the Inupiat communities of Barrow, Nuiqsut, and Kaktovik within the North Slope Borough. The Environmental Justice Executive Order includes consideration of potential effects to Native subsistence activities.

All of the alternatives for Sales 186, 195, and 202, except Alternative II No Action, assume the same amount of oil and for purposes of environmental justice analysis the same levels of activity for the alternatives and sales. These similarities, along with the unique focus of environmental justice, result in a different analytical structure and format. Therefore, the environmental justice analysis that follows does not mirror the format used for other resource categories.

IV.C.16.b. Demographics

IV.C.16.b(1) Race

In 1993, the North Slope Borough conducted the North Slope Borough Census of Population and Economy. It found that of the 6,538 Borough residents, 4,941 identified themselves as Native and 1,597 identified themselves as non-Native. Of the Native population, 97.71% or 4,828 were Inupiat Eskimo. The 1998 Census conducted by the North Slope Borough identified 7,555 Borough residents, with 5,485 reporting as Native and 2,096 as non-Native. Of the 1998 Native population, 96.83%, or 5,285, were Inupiat Eskimo. For the North Slope Borough as a whole in 1993, the population was 73.9% Inupiat and 26.1% non-Inupiat; in 1998, the population was 72.24% Inupiat and 27.76% non-Inupiat (North Slope Borough, 1995, 1999). The 2000 Census counted 7,385 persons resident in the North Slope Borough; 5,050 identified themselves as American Indian and Alaska Native for a 68.38% indigenous population (USDOC, Bureau of the Census, 2000).

The 1993 figures show that of the Inupiat population, 69% of the North Slope Borough population resided in the three communities of Barrow, Nuiqsut, and Kaktovik (North Slope Borough, 1995); 49.2% lived in Barrow, and 50.8% lived in the other seven villages that comprise the North Slope Borough. In 1998, 61.4% of the North Slope Borough population resided in Barrow, and 38.6% lived in the other seven Borough villages; 70.38% lived in the communities of Barrow, Nuiqsut, and Kaktovik (North Slope Borough, 1995, 1999).

In the potentially affected communities of Barrow, Nuiqsut, and Kaktovik, there are no significant “other minorities.” In Nuiqsut, “other minorities” comprised 1.4% of the total population of 420 in 1998, and in Kaktovik, 2.0% of the total population of 256 in 1998. In Barrow in 1998, “other minorities” constituted 16.8% of the total population of 4,641, but the Inupiat minority population is the only minority population allowed to conduct subsistence hunts for marine mammals. “Other minorities” are not allowed to participate in the subsistence marine mammal hunt and do not constitute a potentially affected minority population (North Slope Borough, 1999).

Because of the North Slope Borough’s homogenous Inupiat population, it is not possible to identify a “reference” or “control” group within the potentially affected geographic area, for purposes of analytical comparison to determine if the Inupiat are affected disproportionately. This is because a non-minority group does not exist in a geographically dispersed pattern along the potentially affected area of the North Slope.

IV.C.16.b(2) Income

According to the U.S. Department of Commerce, the average household income in 1993 for the State of Alaska was $64,652, and the average State per capita income was $23,000. Based on Department of Commerce data, the Alaska Department of Labor has portrayed the North Slope Borough as having one of the highest per capita incomes in the State; but data collected by the North Slope Borough 1993 Census of Population and Economy take exception to these figures based primarily on different methods used in data collection. Federal data use a sampling procedure, but the Borough conducts house-to-house household surveys. Also, Federal figures include “transfer payments” such as unemployment, welfare, Social Security, and Medicare/Medicaid payments. The North Slope Borough survey includes all income reported to the Internal Revenue Service, including Alaska Permanent Fund and Alaska Native Claims Settlement Act corporation dividends. The North Slope Borough figures determined an average household income of $54,645 and a per capita income of $15,218 in 1993. When figured for ethnicity, the average Inupiat household income was $44,551 and for non-Inupiat it was $74,448. The average Inupiat per capita income was $10,765 and the non-Inupiat per capita income was $29,525. Of all the households in the North Slope Borough surveyed, 23% qualified as very low-income households, and another 10% qualified as low-to-moderate-income households. As 66% of the total households surveyed were Inupiat, it would appear that a large part of the households falling in the very low- to low-income range are Inupiat. Poverty-level families in the North Slope Borough numbered 88, or 6% of all households. Poverty-level thresholds used by the North Slope Borough were based on the U.S. Bureau of the Census, March 1996 Current Population Survey; low income is defined by the U.S. Census Bureau as 125% of poverty level (North Slope Borough, 1995, 1999).

The North Slope Borough 1998/1999 Economic Profile and Census Report showed household income increasing from $54,645 in 1993 to $63,884 in 1998. The average Inupiat household income increased by an average of $11,685, from $44,551 to $56,236. The average Inupiat per capita income rose from $10,765 in 1993 to $12,550 in 1998. One hundred five households qualified as poverty level, and 37 qualified as very low income. This translates into a total of 381 individuals living below the poverty level, an increase of 12 individuals since 1993 (North Slope Borough, 1999).

IV.C.16.c. Consumption of Fish and Game

As defined by the North Slope Borough Municipal Code, subsistence is “an activity performed in support of the basic beliefs and nutritional need of the residents of the borough and includes hunting, whaling, fishing, trapping, camping, food gathering, and other traditional and cultural activities” (State of Alaska, Dept. of Natural Resources, 1997). This definition gives only a glimpse of the importance of the practice of the subsistence way of life in Inupiat culture, but it does underscore that it is a primary cultural and nutritional activity on which Native residents of the North Slope depend. For a more complete discussion of subsistence and its cultural and nutritional importance, see Section III.C.2 - Subsistence-Harvest Patterns. For statements of the traditional importance of subsistence practices, see Inupiat traditional knowledge commentary in Sections IV.C.11 - Effects of Noise, Disturbance, and Oil Spills on Subsistence-Harvest Patterns, and IV.C.12 - Effects of Noise, Disturbance, and Oil Spills on Sociocultural Systems. See also the Cumulative Effects and the Affected Environment sections for these resources for more traditional knowledge.

Potential effects focus on the Inupiat communities of Barrow, Nuiqsut, and Kaktovik within the North Slope Borough. The sociocultural and subsistence activities of these Native communities could be affected by accidental oil spills. Possible oil-spill contamination of subsistence foods is the main concern regarding potential effects on Native health. Interestingly, after the *Exxon Valdez* spill, testing of subsistence foods for hydrocarbon contamination from 1989-1994 revealed very low concentrations of petroleum hydrocarbons in most subsistence foods. In fact, the U.S. Food and Drug Administration concluded that eating food with such low levels of hydrocarbons posed no significant risk to human health (Hom et al., 1999). They recommended avoiding shellfish, which accumulates hydrocarbons. Of course, human health could be threatened in areas affected by oil spills; however, we can reduce these risks through timely warnings about spills, forecasts about which areas may be affected, and even evacuating people and avoiding marine and terrestrial foods that may be affected. Federal and State agencies with health-care responsibilities would have to sample the food sources and test for possible contamination.

Whether subsistence users will use potentially tainted foods is entirely another question that involves cultural "confidence" in the purity of these foods. Based on surveys and findings in studies of the *Exxon Valdez* spill, Natives in affected communities largely avoided subsistence foods as long as the oil remained in the environment. Perceptions of food tainting and avoiding use remained (and remain today) in Native communities after the *Exxon Valdez* spill, even when agency testing maintained that consumption posed no risk to human health (State of Alaska, Dept. of Fish and Game, 1995a; Hom et al., 1999; Burwell, 1999).

The ability to assess and communicate the safety of subsistence resources following an oil spill is a continuing challenge to health and natural resource managers. After the *Exxon Valdez* spill, analytical testing and rigorous reporting procedures to get results out to local subsistence users were never completely convincing to most subsistence users about the safety of their food, because scientific conclusions often were not consistent with Native perceptions about environmental health. According to Peacock and Field (1999), a discussion of subsistence-food issues must be cross-disciplinary, reflecting a spectrum of disciplines from toxicology, to marine biology, to cultural anthropology, to cross-cultural communication, to ultimately understanding disparate cultural definitions of risk perception itself. Any effective discussion of subsistence-resource contamination must understand the conflicting scientific paradigms of Western science and traditional knowledge in addition to the vocabulary of the social sciences in reference to observations throughout the collection, evaluation, and reporting process. True restoration of environmental damage, according to Picou and Gill (1996), "must include the reestablishment of a social equilibrium between the biophysical environment and the human community" (Field et al., 1999; Nighswander and Peacock, 1999; Fall et al., 1999). Since 1995, subsistence restoration resulting from the *Exxon Valdez* oil spill has improved by taking a more comprehensive approach by partnering with local communities and by linking scientific methodologies with traditional knowledge (Fall et al., 1999; Fall and Utermohle, 1999).

IV.C.16.d. Summary of Human Health Effects

In Alaska initiatives researching contaminants in subsistence foods include a 1999 report by the Alaska Native Health Board: *Alaska Pollution Issues.* After assessing the risks from radionuclides, persistent organic pollutants, heavy metals, polychlorinated biphenyls, dioxins, and furans, the Health Board report concluded that the "benefits of a traditional food diet far outweigh the relative risks posed by the consumption of small amounts of contaminants in traditional foods" (Alaska Native Health Board, 1999). A 1998 report, *Use of Traditional Foods in a Healthy Diet in Alaska: Risks in Perspective*, by the Alaska Department of Health and Social Services essentially came to the same conclusion as the Native Health Board report. It did suggest that Alaska has a critical need to examine human biomarkers of polychlorinated biphenyl exposure and that more studies on polychlorinated biphenyl concentrations in the serum of Alaska Natives is needed. Such information would be the most relevant in determining polychlorinated biphenyl exposure through the subsistence food chain. A comprehensive statewide screening study was advocated (Egeland, Feyk, and Middaugh, 1998).

In 2001, The Alaska Native Health Board put out the *Alaska Pollution Issues Update* report. The report was the first real attempt in Alaska to combine contaminant levels in subsistence foods, actual subsistence food consumption levels by Alaska Natives, and Food and Drug Administration and the Environmental Protection Agency action levels in order to come up with actual health advisories. Its overall conclusion was that "a small number of traditional foods contain contaminants with concentrations that are over the Food and Drug Administration action level, but most have levels below the action level. With the wide margin built in, for establishing the Food and Drug Administration action level, the results should be reassuring to consumers of traditional foods. To determine definitively if these low levels are harmful only ongoing research that measures contaminant levels in Native populations will provide the answer" (Alaska Native Health Board, 2002).

IV.C.16.e. Standard and Potential Mitigation and Ongoing Mitigating Initiatives

One overarching way MMS has tried to address Native concerns has been to include local Inupiat Traditional Knowledge in the text of lease-sale and production EIS's. This process was followed for Sale 170, and the Liberty Project EIS's, and these concerns are found in the Subsistence and Sociocultural sections that analyze noise and oil-spill impacts (see Section IV.C.11 - Subsistence-Harvest Patterns and Section IV.C.10 - Sociocultural Systems). Traditional knowledge will be considered by the decisionmakers when they develop their Records of Decision for the proposed activities.

IV.C.16.e(1) Noise and Disturbance-Related Mitigation

Several mitigating measures are assumed to be in place for the Beaufort Sea multiple sales, and this assumption is reflected in discussions about effects. Mitigation that would apply to subsistence-harvest patterns includes standard proposed Stipulation 2 - Orientation Program, Stipulation 4 - Industry Site-Specific Bowhead Whale Monitoring Program, and Stipulation 5 - Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvesting Activities. Proposed stipulations developed specifically for this EIS are Stipulation 6a - No Permanent Facility Siting in the Vicinity Seaward of Cross Island, Stipulation 6b - No Permanent Facility Siting in the Vicinity Shoreward of Cross Island, and Stipulation 7 - Pre-booming Requirements for Fuel Transfers.

Stipulation 2 - Orientation Program requires the lessee to educate people working on exploration, development, and production about the environmental, social, and cultural concerns that relate to the area and its communities. The program should increase workers' sensitivity to, and understanding of, values, customs, and lifestyles of local Native communities and help prevent conflicts with subsistence activities. The overall training program will be submitted to the Regional Supervisor, Field Operations (RS/FO) for review and approval. Personnel will receive appropriate training on at least an annual basis, and full training records will be maintained for at least 5 years.

Stipulation 4 Industry Site-Specific Bowhead Whale-Monitoring Program requires lessees proposing to conduct exploratory drilling operations, including seismic surveys, during the bowhead whale migration to conduct a site-specific monitoring program approved by the RS/FO; unless, based on the size, timing, duration, and scope of the proposed operations, the RS/FO, in consultation with the North Slope Borough (NSB) and the Alaska Eskimo Whaling Commission (AEWC), determines that a monitoring program is not necessary. The monitoring program would assess when bowhead whales are present in the vicinity of lease operations and the extent of behavioral effects on bowhead whales due to these operations.

This stipulation helps reduce effects to subsistence-harvest patterns and to the overall sociocultural systems, which place special value on the bowhead whale harvest and the sharing of 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. Other positive aspects of this stipulation in terms of subsistence and sociocultural concerns would be the involvement of the Native community in the selection of peer reviewers and in providing observers for the monitoring effort.

Stipulation 5 - Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvesting Activities requires industry to avoid unreasonable conflict with subsistence activities during operations, especially the bowhead whale hunt. Before submitting a plan, the lessee must consult with the subsistence communities of Barrow, Nuiqsut, and Kaktovik; the NSB; and the AEWC about the proposed operations. These consultations ensure that they coordinate siting and timing with subsistence whaling and other subsistence-harvest activities.

In the event no agreement is reached between the parties, the lessee, the AEWC, the NSB, the National Marine Fisheries Service (NMFS), or any of the subsistence communities that could be affected directly by the proposed activity may request that the RS/FO assemble a group consisting of representatives from the subsistence communities, AEWC, NSB, NMFS, and the lessee(s) to specifically address the conflict and attempt to resolve the issues before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests. Upon request, the RS/FO will assemble this group, if the RS/FO determines such a meeting is warranted and relevant, before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests.

The MMS can restrict uses under the lease, if necessary, to prevent conflicts, but subsistence whalers and industry have been able to negotiate agreements that work for both parties. An example is the agreement coordinating the timing of seismic activity for the Northstar Project and the subsistence whale hunt. BPXA and the NSB, AEWC, and city of Nuiqsut worked out this agreement. Existing mitigation requires operators to coordinate siting and timing of projects in a Conflict Avoidance Agreement. The AEWC prefers to negotiate a Conflict Resolution Agreement with industry on an annual basis using a regional, rather than a project-specific, approach to address potential impacts from all ongoing development projects. With the use of the Conflict Avoidance Agreement methodology, Native subsistence whale hunters generally have been successful in reaching their annual whale “take” quotas. Industry may also be required to consult with subsistence communities when activities could directly affect the availability of polar bears for subsistence use and to develop a Plan of Cooperation as part of the Incidental Take Program.

This stipulation helps to reduce noise and disturbance conflicts from oil and gas operations during specific periods, such as the annual spring and fall whale hunts. It requires that the lessees meet with local communities and subsistence groups to resolve potential conflicts. This stipulation reduces potential adverse effects from proposed sales to subsistence harvest patterns, sociocultural systems, and to environmental justice. This stipulation has proven to be effective mitigation in prelease (primarily seismic activities) and exploration activities and through the development of the annual oil/whaler agreement between the AEWC and oil companies.

Potential Stipulations 6a and 6b, which was adopted in Sale 170 as a single stipulation, is divided into two parts. Stipulation 6a will apply the 10-mile radius around Cross Island outside of the barrier islands. Stipulation 6b will apply the 10-mile radius only to those blocks within the barrier islands.

Stipulation 6a - Permanent Facility Siting in the Vicinity Seaward of Cross Island would prohibit permanent OCS production facility siting within a defined 10-mile radius seaward of Cross Island unless the lessee demonstrates to the satisfaction of the Regional Director, in consultation with the NSB and the AEWC, that development would not preclude reasonable subsistence access to whales. In making such a demonstration, the lessee shall follow the processes and requirements for consultation and mitigation of unreasonable conflicts as set out in Stipulation 5.

This stipulation would reduce the potential conflict between subsistence hunting activities and oil and gas development and operational activities with the key areas seaward of Cross Island where subsistence whaling for the community of Nuiqsut occurs. This stipulation could also reduce potential noise from a facility in this area that could deflect bowhead whales further offshore.

Stipulation 6b - Permanent Facility Siting in the Vicinity Shoreward of Cross Island, would prohibit permanent OCS production facility siting within a defined 10-mile radius shoreward of Cross Island unless the lessee demonstrates to the satisfaction of the Regional Director, in consultation with the NSB and the AEWC, that development would not preclude reasonable subsistence access to whales.

This stipulation would reduce the potential conflict between subsistence hunting activities and oil and gas development and operational activities within the area shoreward of Cross Island. However, the whale migration and most whale hunting (based on the whale-strike data) occur outside the Barrier Islands. This stipulation would provide little or no additional protection to subsistence whaling or bowhead whales from that provided by Stipulation 5.

In projects where seismic surveying has been employed, past Conflict Avoidance Agreements have put Inupiat observers on board seismic vessels who, along with biologist observers, are employed by the monitoring contractor to satisfy Conflict Avoidance Agreement and National Marine Fisheries Service requirements. The Inupiat and biologist observers stop seismic operations when they observe marine mammals within the safety radius designated by the National Marine Fisheries Service. Shut down of the airguns occurs if marine mammals are within this radius because of concern about possible effects on hearing sensitivity.

The MMS, along with industry, their contractors, scientists, the North Slope Borough Mayor’s Office and the Wildlife Management Department, and the Alaska Eskimo Whaling Commission, participate in the

National Marine Fisheries Service annual Peer Review Workshop in Seattle to deal with monitoring issues as they relate to the National Marine Fisheries Service administration of its responsibilities for Endangered Species Act and Incidental Harassment Authorization processes. Workshop participants review the results of monitoring efforts to determine the effects of industry activities on marine mammals in the Beaufort Sea and review monitoring plans for the upcoming field season. A noise-monitoring program for marine mammals similar to the one being done for the Northstar Project would be expected for similar development projects and would be considered through the Peer Review Workshop meetings. Any potential monitoring program would be designed to: (1) assess when bowhead and beluga whales and bearded seals are present in the vicinity of development operations and the extent of behavioral effects on these species due to project operations; (2) consider the potential scope and extent of effects that the type of operation could have on these species; and (3) address local concerns of subsistence hunters and integrate Inupiat traditional knowledge.

Other coordination meetings concerning noise impacts included the Arctic Seismic Synthesis Workshop in Barrow in 1997 hosted by MMS that brought together Native whalers, the oil industry, and acoustic scientists to discuss the issue of the distance at which bowheads are deflected from their normal migration path by seismic noise. Whaling captains collectively presented information on distances at which bowhead whales react to seismic vessels. Other concerns raised by local subsistence hunters at those meetings involve issues that are best addressed during the project review and approval process. These concerns include: (1) developing an access agreement for subsistence whalers to gravel production islands that would allow whalers to land on them in case of emergency; (2) establishing marine repeater stations on production islands that would provide a communication and safety benefit to local whalers; (3) establishing some protocol for monitoring air quality that would address long-standing local concerns about air quality in the area; (4) developing a plan for minimizing the number of sealifts and making sure they are completed before the fall subsistence whaling season begins; (5) developing a plan for ongoing Native inspection of production island construction and operation; and (6) developing a plan that ensured that local/Native observers are present during drilling to monitor for potential drill-noise disturbance to marine mammals.

Stipulation 5 provides subsistence whales and hunters the process for meeting with the lessors and operators to resolve these issues.

IV.C.16.e(2) Oil Spill-Related Mitigation Initiatives

Potential Stipulation 7 - Pre-Booming Requirements for Fuel Transfers, would require pre-booming of the fuel barges for fuel transfers (excluding gasoline transfers) of 100 barrels or more that occurred 3 weeks prior to or during the bowhead whale migration. The fuel barge would have to be surrounded by an oil-spill-containment boom during the entire transfer operation to help reduce any adverse effects from a potential spill.

This stipulation would lower the potential effects to subsistence resources and sociocultural systems by providing additional protection to the bowhead whale from potential fuel spills that could occur prior to or during the bowhead whale-migration period. This stipulation would be an added caution in reducing potential harm to migrating bowhead whales and to any tainting of the whales from a spill.

As part of the effort to look at all possible ways to minimize the likelihood of an oil spill, industry, MMS, and the Interagency Working Group have undertaken extensive studies of alternative production pipeline designs to address pipeline safety and oil-spill concerns. Extra-thick-walled pipelines, pipe-in-pipe designs, pipeline burial depths more than twice the maximum 100-year ice-gouging event, and an advanced leak-detection system (LEOS) have been explored to address the prevention of oil spills.

In terms of oil-spill-response initiatives, the MMS and the North Slope Borough are participants in the North Slope Spill Response Project Team that was established to provide areawide spill-response planning for local communities on the North Slope. The MMS has provided the North Slope Borough, the Alaska Eskimo Whaling Commission, the Inupiat Community of the Arctic Slope, and local Native villages information on oil-spill planning, response, and cleanup and ongoing spill-response research initiatives. The MMS has invited local communities and tribal groups to scheduled industry oil-response drills at Prudhoe Bay. Additionally, the MMS held an Alaska Arctic Pipelines Workshop on November 8-9, 1999, in Anchorage to facilitate the exchange of technical information and current research on pipelines in the Arctic between the public, regulators, pipeline designers, and operators. The workshop consisted of presentations and breakout sessions on pipeline design, construction, operations, and maintenance. About 150 persons, including North Slope Borough representatives, participated in the workshop.

The MMS encourages initiatives to train village oil-spill-response teams as a way of guaranteeing local participation in spill response and cleanup; this effort allows local Native communities to use their traditional knowledge about sea ice and the environment in the response process. Within the constraints of Federal, State, and local law, operators and Alaska Clean Seas would be encouraged to hire and train residents of the North Slope Borough and the Cities of Barrow, Nuiqsut, and Kaktovik in oil-spill response and cleanup.

The MMS has worked with the oil industry to develop a comprehensive plan for dealing with subsistence claims, should an oil spill occur. At the present time, the U.S. Coast Guard is reworking their claim process to be more responsive to Native subsistence practices in Alaska. The MMS requires all operators to provide financial responsibility through bonds as required by the Oil Pollution Act of 1990, to ensure they have the means to clean up an oil spill.

Other potential mitigation available if activity occurs includes potential staging of oil-spill equipment at critical locations to support any necessary oil-spill-cleanup operations. This initiative would address response-readiness concerns of subsistence users. Also, the staging of boom material and other pertinent response equipment at Barrow, Cross Island, and Kaktovik would provide protection to critical whaling areas and shoreline. These measures could be included in the oil-spill-contingency plan or in the final Condition of Permit approval letter for a production project issued by the Regional Supervisor for Field Operations.

The oil-spill-contingency plan also could include tactics for protecting bowhead whales. Hazing also could divert bowhead whales away from a spill, if they happened to be in the area at the time of an oil spill.

The MMS acknowledges that present mechanical-cleanup technology has not demonstrated cleanup ability in broken-ice conditions. In-situ burning is a nonmechanical response method available for spill response and could be quite effective in ice conditions, where mechanical cleanup techniques have been proven problematic. Collectively, these standard stipulations and ITL clauses, along with the other rules and regulations governing offshore activities permitted by MMS would aid substantively in mitigating against contamination to onshore habitats and subsistence resources.

IV.C.16.e(3) Mitigating Initiatives Related to Sociocultural Impacts

In evaluating potential sociocultural impacts, the MMS has produced a substantial environmental justice analysis for Alaska as it relates to the Native Alaskan subsistence way of life. Environmental justice analyses have been written for OCS Lease Sale 170, the Bureau of Land Management's recent leasing initiative in the National Petroleum Reserve-Alaska, and the Liberty Project EIS. For the Beaufort Sea multiple sales, the MMS held official meetings in Barrow, Nuiqsut, and Kaktovik under the auspices of environmental justice and consulted with the Native villages of Barrow, Nuiqsut, and Kaktovik and the regional tribal government-(the Inupiat Community of the Arctic Slope) on a government-to-government basis. At these meetings, Inupiat translators always were provided. The environmental justice process followed for the Beaufort Sea multiple-sale process included: (1) initial scoping; (2) environmental justice considerations included in local newspaper notices and local cable TV; and (3) followup meetings that were specific to environmental justice concerns. Some meetings were broadcast over local radio. From this process, the MMS received limited interest and feedback on specific environmental justice criteria. Nevertheless, the MMS heard Inupiat concerns, and discussions about mitigation were conducted. Environmental justice concerns were taken back to MMS management and worked into environmental studies and potential mitigating measures.

Environmental justice concerns were solicited from meetings on the North Slope with the communities of Nuiqsut on October 16, 2001; with Barrow on October 18, 2001; and with Kaktovik on October 19, 2001. A Slopewide government-to-government teleconference arranged through the Inupiat Community of the Arctic Slope was held on December 6, 2001, and involved the tribal governments of Point Hope, Point Lay, Wainwright, Atqasuk, Nuiqsut, and Anaktuvuk Pass. Kaktovik chose not to participate in the teleconference, and a separate meeting with the Native Village of Barrow had already been held in Barrow on October 18, 2001; followup meetings to address environmental justice issues were held with the Inupiat

Community of the Arctic Slope and the Alaska Eskimo Whaling Commission on November 15, 2001. Outside of project coordination, the MMS continues to meet with local North Slope communities and the Inupiat Community of the North Slope on environmental justice concerns and maintains a government-to-government working relationship with these local and regional tribal governments.

Part of MMS's sensitivity to the Inupiat way of life is to ask when it can come to villages to hold meetings. The MMS tries to accommodate village schedules. The MMS continues to take a more collaborative approach in its public involvement and has learned the value of spending more time in these local communities. The MMS has hired a Native community liaison who spends a large part of his time maintaining contacts with local North Slope Native communities and making sure that scoping and public meetings are scheduled so they do not conflict with local activities. The MMS also writes executive summaries for its EIS's that it believes make projects easier for the public to assess. For this EIS, we are translating the Executive Summary into Inupiat. We believe this cooperative approach can lessen the stress of our public involvement mandate, and we welcome suggestions on how to make this process better.

Over a number of projects, the MMS has maintained an ongoing dialogue with the North Slope Borough, the Alaska Eskimo Whaling Commission, the Inupiat Community of the Arctic Slope, and local and tribal governments on the language of lease-sale and development-project mitigating measures.

For half a decade, the MMS has included what the local Inupiat are saying in the text of its lease-sale and production EIS environmental analyses. Native traditional knowledge has been solicited from Inupiat sources that include past and more recent testimony from community meetings on lease-sale hearings in addition to other available published sources of traditional knowledge. This traditional knowledge has been included (with the speaker cited in text and in the bibliography) in the effects analyses sections of the Sale 144 and 170 EIS's, the Northeast National Petroleum Reserve-Alaska EIS, the Liberty Project EIS, and this Beaufort Sea multiple-sale EIS. In this way, traditional knowledge is considered in the planning and decision-making processes and in the formulation of new mitigation. Traditional knowledge used in analysis is peer reviewed by local and regional Native groups.

In-place stipulations that address sociocultural impacts include the Orientation Program stipulation that requires the lessee to instruct its workers on exploration, development, and production projects about the environmental, social, and cultural concerns that relate to the area and its Native communities. The program increases workers' sensitivity to, and understanding of, values, customs, and lifestyles of local Native communities and helps prevent conflicts with subsistence activities. Industry-monitoring programs include specific issues of concern related to wildlife interaction, protection of marine mammals, best management practices to minimize the potential for spills, awareness of local sociocultural issues and concerns, and awareness of subsistence resources and activities. The overall training program will be submitted to the MMS for review and approval. Personnel will receive appropriate training on at least an annual basis.

In Nuiqsut, the oil industry, in coordination with the local community, has established and partially funded a Subsistence Oversight Panel to field the concerns of local subsistence hunters and to monitor local subsistence resources. If offshore development occurs, the MMS will explore ways to support this or other similar panels.

Following a policy of community-based research, the Alaska OCS Region, Environmental Studies Section promotes studies that directly address the standing issues and concerns of Native stakeholders. The MMS includes local and tribal governments in its studies planning process and has held meetings in all local communities to assist their participation in this effort.

Particular studies that the MMS has funded to address sociocultural impacts include the *Collection of Traditional Knowledge of the Alaskan North Slope* study, which is collecting, abstracting, and indexing sources of Inupiat traditional knowledge. The study was awarded to Ukpeagvik Inupiat Corporation, a local Native corporation. The study will produce a traditional knowledge database on CD-ROM for local, State, and Federal agency use that will include a protocol approved by Inupiat elders for the proper use of traditional knowledge by Western researchers. The *MMS's Bowhead Whale Feeding Study*, conducted out of the village of Kaktovik, includes local Inupiat in the study design, data gathering, and data analysis. The study *Subsistence Economies and North Slope Oil Development: Case Studies from Nuiqsut and Kaktovik* examines the continuity and change to subsistence activities experienced in these villages. Other ongoing and funded MMS studies that apply to sociocultural impacts are the *Arctic Nearshore Impact Monitoring In Development Areas (ANIMIDA)* study (designed specifically to meet requests from the Inupiat community), *the Quantitative Description of Potential Effects of OCS Activities on Bowhead Whale Hunting Subsistence Activities in the Beaufort Sea* study, the Alaska Marine Mammal Tissue Archival Project, the *Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow*: Past and Present Comparison study, and *the North Slope Borough Economy, 1965 to Present* study. These studies are discussed in detail under the Cumulative Impacts mitigation section that follows.

Other initiatives include an MMS-sponsored Information Transfer Meeting in Anchorage in January 1999 and the Beaufort Sea Information Update Meeting in Barrow in March 2000, which presented updates on research and studies being conducted in the Beaufort Sea. The March 1999 meeting included presentations by Barrow, Nuiqsut, and Kaktovik whaling captains. Future meetings on the North Slope are expected. The MMS, Alaska OCS Region homepage also maintains an Alaska Native Links page that provides information on the MMS traditional knowledge incorporation process, information on Barrow whaling, and MMS assistance with the bowhead whale census, in addition to links to Alaska Native sites and U.S. Government Native-related sites. The MMS's Native liaison, Albert Barros, was instrumental in getting an Alaskawide Department of the Interior Memorandum of Understanding with Alaskan tribes on government-to-government consultation signed by all the Alaska Department of the Interior Agency Regional Directors.

Over the two decades of MMS involvement in the Arctic, local communities have been very vocal about finding a "compensation" source—impact assistance, revenue sharing, bonds, or mitigation payments—to address impacts from OCS activities. By law, the MMS cannot provide or require industry to provide such compensation. Federal Agencies cannot commit to impact assistance, because that is a role of Congress and not the Executive Branch. Only Congress can alter the OCS Lands Act to include provisions for local impact assistance from MMS revenues or provide the authorization for funding such revenues. Nevertheless, in response to this critical concern, Department of the Interior and MMS staff have done extensive work on developing OCS impact assistance and revenue sharing concepts and frequently have drafted legislative language on this subject in response to Congressional requests. Furthermore, the MMS OCS Policy Committee has developed a white paper on impact assistance and revenue sharing options and has shared this paper and its findings with concerned policymakers. In a one-time effort in 2001, Congress appropriated impact-assistance funds for coastal states affected by oil and gas production. Alaska received an appropriation of $12.2 million, $1,939,680 of which went to the North Slope Borough. Twenty-seven percent of all OCS leasing, rental, and royalty receipts, within the first 3 miles of the Alaska OCS, go to the State of Alaska. Also, subsistence impact funds administered by the U.S. Coast Guard under the Oil Pollution Act of 1990 would be available, in the unlikely event of an oil spill, to provide for subsistence-food losses. For a discussion of Environmental Justice cumulative impacts, see Section V.C.16.

IV.C.16.e(4) Development Benefits

The MMS believes there would be some clear benefits derived from production projects: an ad valorem tax would accrue to the North Slope Borough from new onshore infrastructure (landfall infrastructure and pipelines) associated with such development. Oil from these projects would help keep flow capacity up in the Trans-Alaska Pipeline System, a situation that helps the North Slope Borough's tax base, and additional ad valorem tax would accrue to the North Slope Borough because of increased flow of oil through existing pipeline infrastructure taxed by the Borough. The North Slope Borough received almost $2 million from the State under the Coastal Impact Assistance Program. Industry local-hire initiatives are increasing in terms of the variety of programs being offered to train and attract Inupiat workers for long-term employment on the North Slope. The MMS cannot require local hire, but MMS and other Federal Agencies can inform the operator of the Native concerns for more local employment from nearby oil and gas developments.

Potential benefits include indirect and induced employment that would occur in the government sector that are funded through taxation of oil facilities. While there may not be increases in employment, since the current onshore projects are decreasing in production and taxation value, the increases created by OCS development would help to offset these decreases during the life the OCS projects.

IV.C.16.f. Effects to Communities

The Environmental Justice Executive Order includes consideration of potential effects to Native subsistence activities. Our analysis indicates that the only substantial source of potential environmental justice related effects from Beaufort Sea Sales 186, 195, and 202 to the Native villages would occur in the unlikely event of a large oil spill, which could affect subsistence resources.

IV.C.16.f(1) Disturbance

Disturbance effects to the communities of Barrow, Nuiqsut, and Kaktovik periodically could affect subsistence resources, but no resource or harvest area would become unavailable and no resource population would experience an overall decrease. Our analysis indicates that disturbance and noise from Beaufort Sea multiple sale would not be substantial sources of potential environmental justice effects.

IV.C.16.f(2) Oil Spills

If a spill occurred, oil-spill contact in winter could affect polar bear hunting and sealing. During the open-water season, a spill could affect bird hunting, sealing, and whaling, as well as netting of fish in the ocean. Only the tainting or the potential contamination of the bowhead whale would be considered significant; effects on polar bears and seal would be less so. In the unlikely event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. However, effects are not expected from routine exploration and development activities and operations. Because the chance of one or more large spills [greater than or equal to 1,000 barrels] occurring and entering offshore waters is low, on the order of 10%); it is unlikely that disproportionately high adverse effects to Alaskan Natives would occur from Beaufort Sea multiple-sale activities. Any potential effects on subsistence resources and subsistence harvests are expected to be mitigated substantially, though not eliminated.

IV.C.16.g. Effects by Alternatives and Sales

Effects of Alternatives I, III, IV, V, and VI for Sales 186, 195, and 202. Disturbance effects to the communities of Barrow, Nuiqsut, and Kaktovik periodically could affect subsistence resources, but no resource or harvest area would become unavailable and no resource population would experience an overall decrease. Our analysis indicates that disturbance and noise from Alternative I, III, IV, V, and VI for Sales 185, 196, and 202 would not be substantial sources of potential environmental justice effects.

Our analysis indicates that the only substantial source of potential environmental justice related effects from Sales 185, 196, and 202 to the Native villages would occur in the unlikely event of a large oil spill, which could affect subsistence resources.

If a spill occurred, oil-spill contact in winter could affect polar bear hunting and sealing. During the open-water season, a spill could affect bird hunting, sealing, and whaling, as well as netting of fish in the ocean. Only the tainting or the potential contamination of the bowhead whale would be considered significant; effects on polar bears and seal would be less so. In the unlikely event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. However, effects are not expected from routine exploration and development activities and operations. When we consider the low likelihood of a large spill event (the chance of one or more large spills [greater than or equal to 1,000 barrels] occurring and entering offshore waters is low, on the order of 10%); disproportionately high adverse effects would not be expected on Alaskan Natives from Alternatives I, III, IV, V, and VI for Sales 186, 195, or 202 activities. Any potential effects on subsistence resources and subsistence harvests are expected to be mitigated substantially, though not eliminated.

Conclusion: Environmental justice effects levels under Alternatives I, III, IV, V, and VI for Sales 186, 195, and 202 are expected to be similar to those discussed under effects common to all alternatives. Sale-specific environmental justice effects would derive from potential noise, disturbance, and oil spill effects on subsistence resources, subsistence-harvest patterns, and sociocultural systems. The only substantial source of potential environmental justice related effects to Native villages from Alternatives I, III, IV, V, and VI for Sales 185, 195, and 202 would occur in the unlikely event of a large oil spill, which could affect subsistence resources. In the unlikely event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together.

IV.D. Comparison of the Effects of the Alternatives and the Cumulative Effects

The cumulative effects analysis is presented in the next section (Section V). However, a comparative presentation by resource of the effects of the alternatives and the cumulative effects, including the contribution of Alternative I for Sale 186, is found in Table IV. The table provides summary information for the environmental effects of Alternative I with that of the Barrow Subsistence Whaling Deferral (Alternative III), the Nuiqsut Subsistence Whaling Deferral (Alternative IV), the Kaktovik Subsistence Whaling Deferral (Alternative V), and the Eastern Deferral (Alternative VI) for Sales 186, 195, and 202. The table is based on the conclusions reached for each resource topic.

Following the comparisons of the alternatives is the cumulative-effects conclusion. Not included in this analysis is Alternative II (No Sale Alternative), which represents no action and no direct effects on area resources and, accordingly, is not evaluated. However, there could be effects related to alternative energy sources, as discussed in Section IV.C. The deferral conclusions for the alternatives discuss the effects of the alternative assuming the designated blocks are deferred and standard mitigation listed in Section II.H is in place.

IV.E. Unavoidable Adverse Effects

This section summarizes the unavoidable adverse effects of Alternative I for Sales 186, 195, and 202. Many of the adverse effects identified in Sections IV and V of this EIS would happen only if a large (greater than 1,000-barrel) oil spill occurred; however, such an event is unlikely to happen. The effects of large and very large oil spills are discussed in Section IV.C and IV.I, but they are not included in this analysis because they are not expected to happen. The following analysis identifies unavoidable adverse effects that would occur, if the Sales 186, 195, and 202 are held as scheduled and result in exploration, development, and production.

IV.E.1. Water Quality

Drilling discharges and construction disturbances would have to be permitted (approved) during subsequent environmental reviews and, therefore, could be avoided.

IV.E.2. Lower Trophic-Level Organisms

Permitted drilling discharges and pipeline and platform construction could adversely affect 1% of the benthic organisms in the proposed sale area for Sales 186, 195, and 202, but the organisms would recover within a year.

IV.E.3. Fishes

A few fish could be harmed or killed due to disturbances associated with exploration and production. However, most fish in the immediate area would avoid these activities and would otherwise be unaffected. None of the above effects are expected to be measurable at the population level.

IV.E.4. Essential Fish Habitat

Unavoidable effects on essential fish habitat would be habitat loss due to gravel islands built as drilling platforms, temporary disturbance due to seismic surveys, and turbidity during open-water construction seasons.

IV.E.5. Endangered and Threatened Species

Many of the effects on bowhead whales from noise and disturbance are likely to be unavoidable, but some effects perhaps could be reduced through voluntary compliance with appropriate stipulations and ITL clauses. Unmitigated, uncontrolled noise and other forms of disturbance associated with routine activities (i.e., noise due to seismic surveys, vessel activity, aircraft overflight, drilling activities, or construction activities) likely would cause temporary behavioral responses. These behavioral responses are most likely to occur during the bowhead whale migration or during feeding activities but are not expected to preclude migrations or to disrupt feeding activities on a long-term basis.

Most human disturbance of nesting, staging, or migrating spectacled and Steller's eiders associated with routine activities is considered avoidable through voluntary compliance with the recommendations on aircraft and vessel operation and advisory notes in the proposed ITL on Bird and Marine Mammal Protection, and attention to the exploration/development plan review process that will be followed to ensure eider habitat protection given in the proposed ITL on the Spectacled Eider and Steller's Eider. A small amount of disturbance of spectacled eiders present in the marine environment during the open-water season by helicopters is considered unavoidable. A small amount of offshore habitat used by eiders for staging or foraging would be lost unavoidably if gravel production islands are constructed. Effects on eiders in the unlikely event of a large oil spill are discussed in Sections IV.C.5(b) and (c).

Conclusion. Some unavoidable adverse effects are likely to occur. Bowhead whales exposed to noise-producing activities likely would experience temporary, nonlethal effects. Because alternate habitat areas for foraging and staging are available and disturbance effects temporary and mostly avoidable through compliance with ITL's, effects from these factors on spectacled and Steller's eiders are likely to be insignificant.

IV.E.6. Marine and Coastal Birds

Most human disturbance of nesting, staging, or migrating marine and coastal birds associated with routine activities is considered avoidable through voluntary compliance with the recommendations on aircraft and vessel operation and advisory notes in the proposed ITL on Bird and Marine Mammal Protection. A small amount of disturbance of birds present in coastal and/or marine environments during the open-water season by helicopters is considered unavoidable. A small amount of offshore habitat used by marine and coastal birds for staging or foraging would be lost unavoidably if gravel production islands were constructed.

Conclusion. Because alternate habitat areas for foraging and staging are available and disturbance effects temporary and mostly avoidable through compliance with ITL clauses, effects from these factors on marine and coastal birds are likely to be insignificant.

IV.E.7. Marine Mammals (Pinnipeds, Polar Bears, and Beluga and Gray Whales)

Provisions under the Marine Mammal Protection Act that require the lessees to get Letters of Authorization that direct them to avoid disturbing polar bears dens and require the use of nonlethal means to avoid human-bear interactions. Air, vessel, and ice road traffic and construction activities would unavoidably disturb small numbers of seals and perhaps a few polar bears but this effect would be very brief and not affect seal and bear population abundance and or overall distribution in the Beaufort Sea Planning Area

IV.E.8. Terrestrial Mammals

Some disturbance of terrestrial mammals by air and ice-road traffic and by construction activities is considered unavoidable but short-term and local and would not affect population distribution and abundance.

IV.E.9. Vegetation and Wetlands

Small acreage of tundra habitat would be unavoidably destroyed or altered at gravel mine sites and pad locations.

IV.E.10. Economy

Unavoidable effects would be on employment; associated personal income; and revenues to the North Slope Borough, State of Alaska, and Federal Government. However, most observers consider these effects as positive. Unavoidable effects include the following: Alternative I for Sale 186 would generate increases in North Slope Borough property taxes that would average about 1% above the level of Borough revenues without the sales in the early years, and taper off to less than 0.5% in the later years. Alternative I for Sale 186 in the early years of production would generate increases in revenues to the State of Alaska of less than 0.25% above the level without Sale 186. The increases would taper off to an even smaller percent in the later years of production. The change in total employment and personal income is less than 2% over the 1999 baseline for the North Slope Borough and the rest of Alaska.

Conclusion. Unavoidable effects would be on revenues to the North Slope Borough, State of Alaska, and Federal Government and on employment and associated personal income. However, most observers consider these effects as positive.

IV.E.11. Subsistence-Harvest Patterns

Seals, polar bears, caribou, fish, birds, and especially bowhead whales are important subsistence resources. Noise and disturbance from exploration and development activities, should it occur, could affect subsistence resources periodically in the communities of Barrow, Nuiqsut, and Kaktovik. Additionally, disturbance could cause potential short-term but adverse effects to long-tailed ducks and some eider populations. No harvest areas would be come unavailable for use.

IV.E.12. Sociocultural Systems

Disturbance effects are not expected to displace ongoing sociocultural systems or community activities. However, the inability to harvest sufficient quantities of bowhead whales due to disturbance could cause unavoidable effects on Inupiat traditional practices of harvesting and sharing. Such effects would not displace ongoing sociocultural systems or community activities.

IV.E.13. Archaeological Resources

There may be historic and preserved prehistoric archaeological sites within the proposed lease sale area. Because the exact locations of the sites are not known, the possibility of their disturbance cannot be entirely avoided. The MMS will require archaeological analysis and reports for those blocks where historical or prehistoric resources might exist. Based on the results of this analysis, we will require that any areas identified as containing potential archaeological resources either be investigated further to determine conclusively whether a site exists at the location, or be avoided by all bottom-disturbing activities. The additional investigations will help to ensure that there are no unavoidable effects on archaeological resources.

IV.E.14. Land Use Plans and Coastal Management Programs

The hypothetical scenarios assume that transportation networks between sites on the Beaufort Sea coast will tie into existing infrastructure. As a result, unavoidable adverse effects related to major changes in land use are not anticipated; neither are they expected as a result of disturbance. Unavoidable adverse effects that are related to the scenarios usually would be caused by an oil spill. To the extent that facilities are sited to minimize the effect of an oil spill on the environment, conflicts with the Statewide standards and the North Slope Borough policies of the ACMP are avoidable; therefore, it is expected that activities generally will conform with existing land use and with policies of local, State, and Federal coastal management programs and land use plans.

IV.E.15. Air Quality

Alternative I for Sales 186, 195, and 202 would cause small, local increases in the concentrations of criteria pollutants. Concentrations would be within the PSD Class II limits and National Air Quality Standards.

IV.E.16. Environmental Justice

Disturbance effects on subsistence resources could occur over the lifetime of Sales 186, 195, and 202 but would never reach a significant threshold.

IV.F. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The short-term effects and uses of various components of the environment in and adjacent to the Beaufort Sea area offered in Sales 186, 195, and 202 are related to long-term effects and the maintenance and enhancement of long-term productivity. The effects of the proposed action would vary in kind, intensity, and duration, beginning with preparatory activities (seismic-data collection and exploration drilling) of oil and gas development, and ending when natural environmental balances might be restored.

In general, “short term” refers to the useful lifetime of the proposed action as determined by Alternative I for Sales, 195, and 202; some even shorter-term uses and effects also are considered. “Long term” refers to that time beyond the estimated lifetime of the proposed action. The producing life of the field development in the multiple-sale area has been estimated to be about 28 years; this estimate is based on the resource estimate for Alternative I. In other words, short term refers to the total duration of oil and gas exploration and production, whereas long term refers to an indefinite period beyond the termination of oil and gas production.

Many of the effects discussed in Section IV are considered to be short term (being greatest during the construction, exploration, and early production phases) and could be further reduced by the mitigating measures discussed in Section II.H.

Short-term, localized, adverse effects on biological populations and habitats are expected in the event an unlikely large oil spill occurred in either the marine or terrestrial environments. These potential effects include mortality of individuals, physiological stresses in surviving individuals, reduction in the number of species or species populations in the affected area, changes in the distribution of species or individuals, and changes in behavior or migration patterns. Long-term, cumulative, oil-pollution effects also might occur if recovery from the short-term effects extended beyond the estimated useful life of the proposed action. Some species might have difficulty repopulating physically altered habitats and could be permanently displaced.

The production of oil and gas from the Beaufort Sea multiple-sale area would provide short-term energy and, perhaps, provide time either for the development of long-term alternative-energy sources or substitutes for petroleum feedstocks. Economic, political, and social benefits would accrue from the availability of oil and gas. Most benefits would be short term and would decrease the Nation’s dependency on oil imports. Regional planning would aid in controlling changing economics and populations and, thus, in moderating any adverse effects. If additional supplies were discovered and developed, the proposed production system would enhance extraction. However, consumption of this offshore oil and gas would be a long-term use of nonrenewable resources.

After completion of oil production, oil spills and their effects would not occur, and the marine environment generally would be expected to remain at or return to its normal long-term productivity level. To date, there has been no discernible decrease in long-term productivity in OCS areas where oil and gas have been produced for many years. In areas that have experienced apparent increases in oil pollution, such as the North Sea, some long-term effects appear to have taken place. Populations of pelagic birds have decreased markedly in the North Sea in recent years—prior to the beginning of North Sea oil production. However, in the Prince William Sound, 12 years after the *Exxon Valdez* oil spill, many of the species affected by the spill appear to be well on their way to recovery. In the long term, the species affected by the *Exxon Valdez* Oil Spill may make a full recovery. Although two species are listed as recovered and eight species plus intertidal/subtidal communities as recovering, six species are listed as not recovering and four species with status unknown (*Exxon Valdez* Oil Spill Trustee Council, 2001). Until more reliable data become available, however, the long-term effects of chronic and major spillage of hydrocarbons and other related discharges cannot accurately be projected. In the absence of such data, it must be concluded that the possibility of decreased long-term productivity exists, if chronic spills or a major large oil spill occurred as a result of the proposed action.

IV.F.1. Water Quality

Water quality may be affected by drilling discharges, turbidity from construction activities, and oil spills. The effects of all these activities on water quality would be short-term, recovering within a month.

IV.F.2. Lower Trophic-Level Organisms

Lower trophic-level organisms may be affected by drilling discharges, platform and pipeline construction, and oil spills. The effects of most of these activities would be short-term with populations recovering within a month from large spills, within a year from drilling discharges, and within 3 years from construction. Unusual kelp communities could be affected for a long-term (a decade or longer by construction, as discussed in the Liberty EIS (USDOI, MMS, Alaska OCS Region, 2002a:Section

III.C.3.e). However, the requirement for benthic surveys near special biological habitats (Stipulation 1) would help to prevent the unintentional disturbance of kelp.

IV.F.3. Fishes

Disturbances associated with construction, seismic surveys, drilling operations, and vessel and aircraft traffic may harm or kill a few fish. However, most fish would avoid these short-term activities and would be otherwise unaffected. Disturbances are not likely to result in long-term effects on fish populations.

IV.F.4. Essential Fish Habitat

Disturbances associated with construction, seismic surveys, drilling operations, vessel traffic, and oil spills are expected to be short term with no long-term consequences. Salmon, salmon habitats, and salmon prey are expected to recover within one generation.

IV.F.5. Endangered and Threatened Species

Bowhead whales may be affected by noise from exploration activities, including construction, seismic surveys, drilling operations, vessel and aircraft traffic, and oil spills on a short-term basis, over the life of the project. Most of these activities are relatively temporary. However, in the unlikely event of a large oil spill, residual oil remaining after cleanup operations and any cleanup operations continuing on after the useful life of the project could result in long-term effects to the bowhead population, primarily from noise and disturbance from continuing cleanup activities.

Spectacled and Steller's eiders may experience short-term adverse effects from any factors that disturb their normal daily and seasonal pattern of activities. During normal exploration and development operations, aircraft (helicopter) and vessel traffic are the most important disturbance-causing agents. Foraging and staging habitat lost where production islands are constructed is a long-term effect, but alternative habitat is widespread and, thus, effect on eiders would be short term. The duration of effects resulting from mortality-causing factors, principally collision of eiders with structures, likely will be determined by the magnitude of the loss and the size and status of the regional population. Small losses from the spectacled eider population, currently declining at a nonsignificant rate, are expected to be short-term effects while any substantial loss is likely to be long term. The Steller's eider population, although currently stable or increasing at a nonsignificant rate, is likely to experience a long-term effect from any loss because of the small size of the regional population. Effects on eiders in the unlikely event of a large oil spill are discussed in Sections IV.C.5(b) and IV.C.5(c).

Conclusions: Bowhead whales may be temporarily affected by noise from exploration activities and oil spills on a short-term basis over the life of the project. In the unlikely event of a large oil spill, there could be long-term effects to the bowhead population from residual oil and cleanup activities that continue past the useful life of the project. Effects of disturbance on spectacled and Steller's eiders are expected to be short term. Habitat-modification effects are likely to be short-term, although loss of habitat will be a long-term effect. Any substantial mortality of eiders colliding with structures is likely to be long term, particularly when their populations are in a declining status.

IV.F.6. Marine and Coastal Birds

Marine and coastal birds may experience short-term adverse effects from any factors that disturb their normal daily and seasonal pattern of activities. During normal exploration and development operations, aircraft (helicopter) and vessel traffic are the most important disturbance-causing agents. Foraging and staging habitat lost where production islands are constructed is a long-term effect, but alternative habitat is widespread and effect on birds would be short term. The duration of effects resulting from mortality-causing factors, principally collision of birds with structures, likely will be determined by the magnitude of the loss and the size and status of the regional population. Small losses from populations currently increasing, stable, or declining at a nonsignificant rate are expected to be short-term effects, while a substantial loss experienced by a population in a nonsignificant decline, or any loss experienced by a population declining at a significant rate, is likely to be long term. Any mortality experienced by species whose populations are very small, whether increasing or decreasing at a nonsignificant rate, may result in a long-term effect because of their small size. Effects on marine and coastal birds in the unlikely event of a large oil spill are discussed in Section IV.C.6.

Conclusion: Effects of disturbance on marine and coastal birds is expected to be short term. Habitat-modification effects are likely to be short term, although loss of habitat will be a long-term effect. Any substantial mortality of birds colliding with structures is likely to be long term, particularly when their populations are in a declining status.

IV.F.7. Marine Mammals (Pinnipeds, Polar Bears, and Beluga and Gray Whales)

Noise and disturbance, and habitat alteration from offshore construction activities, and potential oil spills temporarily would affect some individual marine mammals and their habitats. These effects are expected to be local. Disturbances and altered habitat possibly may result in local displacement, mortality, stress, decreases, or reductions in local abundance of some species. Effects possibly could last over the long term, if recovery from the short-term effects extended beyond the field's estimated useful life.

IV.F.8. Terrestrial Mammals

Noise and disturbance, habitat alteration from onshore construction activities, and potential oil spills temporarily would affect some individual terrestrial mammals and their habitats. These effects are expected to be local. Disturbances and altered habitat possibly may result in local displacement, mortality, stress, decreases, or reductions in local abundance of some species. Effects possibly could last over the long term, if recovery from the short-term effects extended beyond the field's estimated useful life.

IV.F.9. Vegetation and Wetlands

Onshore construction activities and potential oil spills would affect some vegetation and wetlands. These effects are expected to be local. Oil spills and construction activities would result in local damage or destruction of a few acres of wetlands. Effects are expected to last over the long term, with recovery of vegetation and wetlands to extend beyond the field's estimated useful life.

IV.F.10. Economy

Increases in employment and associated personal income would occur over the life of the OCS activities. Revenue increases to the North Slope Borough, the State, and the Federal Government would occur during production years. However, none of these increases would be long term. Development activity would result in infrastructure that would enhance long term productivity of oil and gas exploration, development, and production. Economic benefits would accrue from the availability of oil and gas. Most benefits would be short term and would decrease the Nation's dependency on oil imports. Alternative I for Sale 186 would generate increases in North Slope Borough property taxes that would average about 1% above the level of Borough revenues without the sales in the early years and taper off to less than 0.5% in the latter years. Alternative I for Sale 186 in the early years of production would generate increases in revenues to the State of Alaska of less than 0.25% above the level without Alternative I for Sale 186. The increases would taper off to an even smaller percent in the latter years of production. The change in total employment and personal income is less than 2% over the 1999 baseline for the North Slope Borough and the rest of Alaska for each of the three major phases of OCS activity. The three major phases are exploration, development, and production. The employment and personal income increase includes workers to cleanup a possible large oil spill of 1,500 barrels or 4,600 barrels. Increases in employment and personal income for Sales 195 and 2002 would be less than 3% over the 1999 baseline. Sales 186, 195, and 202 would probably extend the lifespan of the Trans-Alaska Pipeline.

Conclusion. Increases in employment and associated personal income would occur over the life of the OCS activities. Revenue increases to the North Slope Borough, the State, and the Federal Government would occur during production years. However, none of these increases would be long term. Development activity would result in infrastructure that would enhance long term productivity of oil and gas exploration, development, and production.

IV.F.11. Subsistence-Harvest Patterns

In the short term, redistributing, reducing, tainting, or displacing subsistence species could affect regional subsistence-harvest patterns. Such short-term effects should not have long-term consequences.

IV.F.12. Sociocultural Systems

Short-term effects on subsistence resources would disrupt social systems if they continue over the lifetime of the project. Destroying habitat would locally reduce subsistence species, a long-term effect on the regional subsistence economy and the sociocultural system.

IV.F.13. Archaeological Resources

Archaeological resources finds discovered as a result of the surveys required prior to development of a lease, would enhance long-term knowledge. Overall, such finds could help fill gaps in our knowledge of the history and early inhabitants of the area; but any destruction of archaeological sites or unauthorized removal of artifacts would represent long-term losses.

IV.F.14. Land Use and Coastal Management Programs

Land use changes would occur at shore-base sites and along pipeline routes. In potentially affected areas, short-term changes include a shift in land use from subsistence-based activities to industrial activities throughout the life of the proposed action. Land use changes could be short term in nature if, after production ceased, use of the land reverted to previous uses. Long-term effects on land use could result if use of the infrastructure or facilities continued after the estimated useful life of the proposed action. Potential users could be other resource developers or residents or nonresidents who had become accustomed to the convenience of using existing facilities, such as roads.

IV.F.15. Air Quality

Air pollution resulting from activities under Alternative I for Sales 186, 195, and 202 would be a short-term and local effect. The analysis of air quality effects of the proposal indicates that, although the pristine air quality of the study area may be impaired temporarily and very locally, long-term effects for air quality would be insignificant (see Section IV.C.15).

IV.F.16. Environmental Justice

Short-term effects on subsistence resources that in turn chronically affected the sociocultural system over the lifetime of the project would be considered disproportionate high adverse effects on the Inupiat people. Such an effect is expected to occur only in the unlikely event of a large oil spill.

IV.G. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

This section discusses the irreversible and irretrievable commitment of resources. Many of the adverse effects and all of the significant effects identified in Sections IV and V of this EIS would happen only if a large (1,000 barrels or more) oil spill occurred, but such an event is unlikely to happen. The effects of large and very large oil spills are discussed in Sections IV.C and IV.I, but they are not included in this analysis because they are not expected to happen. The following analysis identifies irreversible and irretrievable commitment of resources that would occur, if Sales 186, 195, and 202 are held as scheduled and result in exploration, development, and production.

The undiscovered, economically recoverable resources assumed to be leased for each lease sale are assumed to be 460 million barrels of oil. Should these resources be recovered, they would be irretrievably consumed. Following are discussions of the assumed effects of this commitment of resources.

IV.G.1. Water Quality

Effects on water quality would be short term, recovering within a month and, therefore, reversible.

IV.G.2. Lower Trophic-Level Organisms

Most effects on lower trophic-level organisms would be reversible, but unusual kelp communities could be buried as a result of construction of islands and pipelines (USDOI, MMS, Alaska OCS Region, 2002a:Section III.C.3.e). However, the magnitude of kelp effects would be moderated by required benthic surveys.

IV.G.3. Fishes

No measurable effects on fish populations are likely due to disturbances, discharges, or noise. Hence, no irreversible or irretrievable commitment of fish resources is likely.

IV.G.4. Essential Fish Habitat

Effects on salmon essential fish habitat are short term, recovering within one generation and, therefore, reversible.

IV.G.5. Endangered and Threatened Species

Some bowhead whales could be subjected to temporary nonlethal effects of disturbance due to noise from seismic activities, vessel and aircraft traffic, and drilling activities. In addition, there could be some loss and/or deterioration of habitat due to facility developments, although these would be very minor. It is unlikely that such effects would lead to permanent (irreversible) losses of these resources for bowhead whales (see Section IV.C.5). The bowhead population is increasing, so any mortality is likely to be relatively temporary and reversible.

It is possible that habitats used by spectacled and Steller's eiders for nesting, staging, or foraging could be irretrievably or irreversibly altered by activities associated with petroleum exploration and development (e.g., burial by gravel), and there may be some localized but temporary disturbance effects on eiders. However, there are alternate habitat areas available in which these activities may take place, and disturbance effects are expected to be temporary. Collision of broodrearing, staging, or migrating eiders with offshore or onshore structures may result in the death of some individuals. Such losses may affect the regional population trend of spectacled eiders, which shows a non-significant downward trend in the past decade, and Steller's eider, which shows a nonsignificant upward trend over the same time period. Effects on eiders in the unlikely event of a large oil spill are discussed in Sections IV.C.5(b) and IV.C.5(c).

Conclusion. Because the bowhead whale population is increasing and effects from noise are likely to be temporary, no irreversible losses to bowhead whales are likely. Because alternate habitat areas for critical activities are available and disturbance effects would be temporary, no irretrievable or irreversible effects on spectacled or Steller's eiders from these factors are likely. However, losses of individual eiders through collision mortality are irretrievable, and such losses may result in an irreversible effect while the regional population of spectacled eiders, for example, is declining.

IV.G.6. Marine and Coastal Birds

It is possible that habitats used by marine and coastal birds for nesting, staging, or foraging could be irretrievably or irreversibly altered by activities associated with petroleum exploration and development (for example, burial by gravel), and there may be some localized but temporary disturbance effects on birds. However, there are alternate habitat areas available in which these activities may take place, and disturbance effects are expected to be temporary. Collision of broodrearing, staging, or migrating birds with offshore or onshore structures may result in the death of some individuals. Such losses may affect the regional population trend of any species, whether such trends are upward or downward or significant or nonsignificant over the period of measurement.

Conclusion. Because alternate habitat areas for critical activities are available and disturbance effects temporary, no irretrievable or irreversible effects on marine and coastal birds from these factors are likely. However, losses of individual birds through collision mortality are irretrievable, and such losses may result in an irreversible effect while the regional population of a species is declining.

IV.G.7. Marine Mammals (Pinnipeds, Polar Bears, and Beluga and Gray Whales)

Seals, walruses, polar bears, and beluga and gray whales could be subjected to disturbance due to noise and movement of aircraft and vessels and other human activities, or losses and/or deterioration of habitat due to facility developments. It is unlikely that such effects would lead to permanent (irreversible) losses of these resources (see Sec. IV.C.7 - Effects on Pinnipeds, Polar Bears, and Beluga, and Gray Whales).

IV.G.8. Terrestrial Mammals (Caribou, Muskox, Grizzly Bear, and Arctic Fox)

Caribou, muskoxen, grizzly bears, and arctic foxes could be subjected to direct and indirect effects disturbance due to noise and movement of aircraft and motor vehicles and other human activities, or losses and/or deterioration of habitat due to facility developments. It is unlikely that such effects would lead to permanent (irreversible) losses of these resources (see Section IV.C.7 - Effects on Caribou, Muskox, Grizzly Bear, and Arctic Fox).

IV.G.9. Vegetation and Wetlands

A small acreage of tundra habitat would be irreversibly altered by gravel fill at the pipeline-valve pads and at gravel mine sites on the North Slope.

IV.G10. Economy

Increases in employment and personal income would occur over the life of the OCS activities. Revenue increases to the North Slope Borough, the State, and Federal Government would occur during production years. These would constitute irreversible and irretrievable commitment of resources. Development activity would result in infrastructure, but that infrastructure could be removed.

Sales 186, 195, and 202 would generate increases in North Slope Borough property taxes that would average about 1% above the level of Borough revenues without the sales in the early years, and taper off to less than 0.5% in the later years. Sale 186 in the early years of production would generate increases in revenues to the State of Alaska of less than 0.25% above the level without Sale 186. The increases would taper off to an even smaller percent in the latter years of production. The change in total employment and personal income is less than 2% over the 1999 baseline for the North Slope Borough and the rest of Alaska for each of the three major phases of OCS activity. Increases in employment and personal income for Sales 195 and 2002 would be less than 3% over the 1999 baseline. Sales 186, 195, and 202 probably would extend the lifespan of the Trans-Alaska Pipeline.

Conclusion. Increases in employment and personal income would occur over the life of the OCS activities. Revenue increases to the North Slope Borough, the State, and Federal Government would occur during production years. These would constitute irreversible and irretrievable commitment of resources. Development activity would result in infrastructure, but that infrastructure could be removed.

IV.G.11. Subsistence-Harvest Patterns

Subsistence resources could be subjected to direct and indirect effects from noise, disturbance, and oil spills. It is unlikely that such effects would lead to permanent (irreversible) losses of these resources.

IV.G.12. Sociocultural Systems

Sociocultural systems could be subjected to the indirect effects of noise, disturbance, and discharge as they affected subsistence resources. It is unlikely that such effects would lead to permanent (irreversible) losses to sociocultural systems or community practices.

IV.G.13. Archaeological Resources

Archaeological resources could be subjected to the effects of seafloor disturbance and onshore construction. Although the effects of offshore activity would be greatly mitigated by archaeological surveys and avoidance, any damage or destruction to archaeological resources would be irreversible and the archaeological information lost would be irretrievable.

IV.G.14. Land Use Plans and Coastal Management Programs

No conflicts with the Statewide standards of the Alaska Coastal Management Plan or the enforceable policies of the North Slope Borough Coastal Management Plan are anticipated.

IV.G.15. Air Quality

The modeling analyses for oil and gas development projects indicate that the highest pollutant concentrations would be confined to areas within a short range of the facility. Because of shifting winds and changing meteorological conditions, the concentrations at any one particular location would be quite variable, with the higher concentrations lasting for a short duration (typically a few hours up to a day). However, these episodes could reoccur throughout the life of the project. The predicted concentrations are below the levels considered to be harmful to health and welfare and would meet the ambient air quality standards set by the Environmental Protection Agency. Thus, no adverse impacts would be expected and, thus, they would be reversible.

IV.G.16. Environmental Justice

Subsistence resources and sociocultural systems would be subjected to direct and indirect effects from noise, disturbance, and discharges. It is unlikely that such effects would lead to permanent (irreversible) losses to these resources, to the sociocultural system, or to Inupiat culture.

IV.H. EFFECTS OF NATURAL GAS DEVELOPMENT AND PRODUCTION

Natural gas may be discovered in the Alternative I for Sales 186, 195 and 202 areas during exploration drilling. Although gas resources are not considered economic to exploit at this time or in the foreseeable future (see Appendix A), they could be developed and produced at some undetermined future time. Under such circumstances, natural gas production probably would not occur until after oil production had begun. Thus, leases containing unassociated natural gas that could be recoverable in the future probably could be retained by the leaseholder. (Associated and dissolved gases that are recovered along with the crude oil are expected to be reinjected or used as fuel, depending on the amount recovered.) The effects of potential gas development and production on the environment of Alternative I for Sales 186, 195, and 202 and adjacent areas that would be additional to the effects associated with oil development and production are described in this section.

Additional facilities and infrastructure would be needed if and when the nonassociated natural gas is developed and produced. The gas could be produced through wells drilled from gas-production platforms.

A large-diameter pipeline would be installed to transport the produced gas from the production platform(s) to an onshore gas-processing facility most likely located in the Prudhoe Bay area; the gas pipeline would be separate from any oil pipelines to the extent necessary to minimize the risks that would arise during installation and operation; however, the main trunk gas pipeline would be constructed parallel to the trunk oil pipeline. No offshore booster-pump stations would be required between the platforms and the gas facility; however, in the Far Zone, with unknown reservoir pressures and distance from onshore gas processing facilities, gas flow still is an unknown.

After processing, the gas would be transported to the continental U.S. via pipeline. The gas pipeline would follow a route paralleling the Trans-Alaska Pipeline System to the Fairbanks area. From there the pipeline route would travel east along the Alaska-Canada Highway into Canada; it would parallel the existing highway system and follow a pipeline corridor permitted in 1976 for gas transport. Another route under consideration is a subsea Beaufort Sea pipeline from the Prudhoe Bay area to the Canadian Mackenzie River, then south through Canada to tie into Canadian gas production before being distributed in the lower 48 states. Both these routes are still under economic and engineering feasibility studies. Effects of natural gas development and production on the biological resources, social systems, and physical regimes of the Alternative I for Sales 186, 195, and 202 area and adjacent areas could be caused by gas blowouts; installing offshore pipelines and gas-production systems; drilling gas-production wells; installing onshore pipelines and a gas-processing facility; marine-, surface-, and air-traffic noise and disturbance; construction activities; and growth in the local economy, population, and employment.

Accidental emissions of natural gas could result from a gas-well blowout or a pipeline rupture. In the unlikely case that such an event occurred, a gas-well blowout probably would not persist for more than 1 day and would release perhaps 20 metric tons of gaseous hydrocarbons; 60% of all blowouts since 1974 have lasted 1 day or less. From such a blowout, a hazardous plume of gas could extend downwind for about a kilometer but would dissipate quickly once the blowout ceased. The amount of volatile organic compounds released by such a blowout would be less than that evaporated from an oil spill greater than or equal to 1,000 barrels.

The rupture of a gas pipeline would result in a short-term release of gas. A sudden decrease in gas pressure automatically would initiate procedures to close those valves that would isolate the ruptured section of the pipeline and thus prevent a further escape of gas.

IV.H.1. Water Quality

Drilling discharges and construction of offshore platforms and pipelines for natural gas exploration and development are expected to affect water quality. The increased turbidity from permitted construction activities would be local and short term. Trace metals from permitted discharges of drilling muds and cuttings over the life of the field could exceed sublethal levels over only a few square kilometers.

IV.H.2. Lower Trophic-Level Organisms

Natural gas exploration and development is expected to affect lower trophic level organisms because of the construction of offshore platforms and pipelines. Construction is estimated to adversely affect less than 1% of the immobile benthic organisms in the Alternative I Sales 186, 195, and 202 areas. Recovery is expected within 3 years. Unusual kelp communities could be affected longer, but effects would be moderated by required benthic surveys. The communities are expected to slowly colonize and to benefit from some new gravel islands.

IV.H.3. Fishes

Natural gas exploration and development could adversely affect arctic fish from either a natural gas blowout or the construction of overland gas pipelines. In the unlikely event of a natural gas blowout occurred, some fish in the immediate vicinity might be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. In general, very few fish are likely to be affected by a blowout, and any effects would not be measurable at the population level. The construction of overland gas pipelines through waters supporting fish is likely to displace small numbers of fish short distances. However, those affected would soon reoccupy that habitat upon completion of the activities and would be otherwise unaffected. For these reasons, natural gas exploration and development is not likely to have a measurable effect on fish populations.

IV.H.4. Essential Fish Habitat

Drilling discharges and construction of offshore platforms and pipelines for natural gas exploration and development is expected to affect water quality in estuarine and marine essential fish habitat and prey habitat for salmon. The increased turbidity from permitted construction activities would be local and short term. Trace metals from permitted discharges of drilling muds and cuttings over the life of the field could exceed sublethal levels over only a few square kilometers. Recovery is expected within one generation.

IV.H.5. Endangered and Threatened Species

Development and production of natural gas fields in the Beaufort Sea likely would have temporary, nonlethal effects on bowhead whales. Installation of gas-production platforms and construction of gas pipelines would be similar to the installation of oil-production platforms and construction of oil pipelines as described in Section IV.C.5. Most effects would result from air and vessel traffic associated with construction and operation of production platforms and offshore-pipeline installation during the open-water season. Most bowhead whales are likely to avoid these activities by swimming around them during their migration. Much of the construction activity associated with the development and production of natural gas fields may occur during the winter and would have little effect on bowhead whales.

If a natural gas blowout occurred, some bowhead whales in the immediate vicinity of the blowout could be injured or killed. Emissions of gaseous hydrocarbons from the blowout would be hazardous to any organisms exposed to high concentrations. However, the blowout would likely not persist more than a day and gaseous hydrocarbons would be dispersed very rapidly from the blowout site. It is likely that few bowhead whales would be affected by these hydrocarbons from the blowout. The bowhead population is increasing, so any mortality is likely to be relatively short-term.

Likewise, development and production of natural gas fields likely would have temporary, nonlethal effects on spectacled and Steller's eiders. Most effects would result from air and vessel traffic associated with construction and operation of production platforms and offshore-pipeline installation during the open-water season. Most spectacled and Steller's eiders are likely to avoid the sites of these activities by altering their routes of movement in the vicinity. Much of the construction activity associated with the development and production of natural gas fields may occur during the winter and would have little effect on eiders, but could destroy a small amount of foraging habitat.

If a natural gas blowout occurred, some eiders in the immediate vicinity could be injured or killed, although this is not very likely given their generally dispersed distribution. Emissions of gaseous hydrocarbons from the blowout would be hazardous to any organisms exposed to high concentrations. However, the blowout likely would not persist more than a day and gaseous hydrocarbons would be dispersed very rapidly from the blowout site. It is likely that few spectacled and Steller's eiders would be affected by these hydrocarbons from the blowout.

Conclusion. Development and production of natural gas fields in the Beaufort Sea likely would have temporary, nonlethal effects on bowhead whales. If a natural gas blowout occurred, some bowhead whales in the immediate vicinity of the blowout could be injured or killed. It is likely that few bowhead whales would be affected by these hydrocarbons from the blowout. The bowhead population is increasing, and any mortality is likely to be relatively short-term. The effect of natural gas field development on spectacled and Steller's eiders also is likely to be temporary and nonlethal. If a natural gas blowout occurred, some eiders in the immediate vicinity of the blowout could be injured or killed, but it is likely that few would be affected by hydrocarbons from the blowout. No population-level effects on eiders are expected.

IV.H.6. Marine and Coastal Birds

Development and production of natural gas fields likely would have temporary, nonlethal effects on marine and coastal birds. Most effects would result from air and vessel traffic associated with construction and operation of production platforms and offshore-pipeline installation during the open-water season. Most birds are likely to avoid the sites of these activities by altering their routes of movement in the vicinity. Much of the construction activity associated with the development and production of natural gas fields may occur during the winter and would have little effect on migratory birds, but could destroy a small amount of foraging habitat.

If a natural gas blowout occurred, some birds in the immediate vicinity could be injured or killed. Emissions of gaseous hydrocarbons from the blowout would be hazardous to any organisms exposed to high concentrations. However, the blowout likely would not persist more than a day and gaseous hydrocarbons would be dispersed very rapidly from the blowout site. It is likely that few marine and coastal birds would be affected by these hydrocarbons from the blowout.

Conclusion. Effect of natural gas field development on marine and coastal birds also is likely to be temporary and nonlethal. If a natural gas blowout occurred, some birds in the immediate vicinity of the blowout could be injured or killed, but it is likely that few would be affected by hydrocarbons from the blowout. No population-level effects on birds are expected.

IV.H.7. Marine Mammals (Pinnipeds, Polar Bear, and Beluga and Gray Whales)

The most likely effect of natural gas development and production on pinnipeds, polar bears, and beluga and gray whales would come from air traffic to and from the production platforms and the support facility (probably at Deadhorse) and from platform and offshore-pipeline installation. The air traffic associated with gas production would be an additive source of noise and disturbance of marine mammals. However, the effect of this noise and disturbance is likely to be very brief and result in only a temporary displacement of some marine mammals along the flight paths (a short-term effect).

The effect of installing gas-production platforms and laying gas pipelines would be similar to the effect of installing oil-production platforms and laying oil pipelines. These activities would temporarily (1-3 seasons) alter the availability of some food organisms of marine mammals near the gas-production platforms and along the pipeline routes. Although this effect could be additive to the habitat alterations associated with oil development, the changes in availability of some food organisms of marine mammals would likely be short term and local (within about 1.6 kilometers [1 mile] of the activity).

If a natural gas blowout occurred, with possible explosion and fire, marine mammals in the immediate vicinity of the blowout could be killed, particularly if the explosion occurred below the water surface. Natural gas and gas condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. However, natural gas vapors and condensates would be dispersed very rapidly from the blowout site; it is not likely that these pollutants would affect any marine mammals except individuals present in the immediate vicinity of the blowout (the loss of probably fewer than 100 animals with such losses replaced within 1 year). For any marine mammals to be exposed to high concentrations of gas vapors or condensates, the blowout would have to occur below or on the surface of the water, not from the top of the platform or gravel island.

Conclusion. The effects of natural gas development on pinnipeds, polar bears, and beluga and gray whales would likely be short term (1 year or less) and local (within about 1.6 kilometers [1 mile] of blowouts, noise and disturbance, and platform- and pipeline-installation activities).

IV.H.8. Terrestrial Mammals (Caribou, Muskox, Grizzly Bear, and Arctic Fox)

The most likely effects of natural gas development and production on caribou, muskoxen, grizzly bears, and arctic foxes would come from motor-vehicle traffic and construction activities associated with installing the onshore part of the pipeline systems that connect the production platforms with the onshore-processing facility. Onshore, the gas pipelines would run parallel to the oil pipelines and would be serviced by the same roads. The gas pipelines probably would be buried. Road-traffic disturbance of caribou, and muskox along the gas-pipeline routes would be most intense during the construction period, when motor-vehicle traffic is highest, but would subside after construction is complete. Caribou, muskoxen, grizzly bears, and arctic foxes are likely to successfully cross the pipeline corridor within a short period of time (perhaps within a few hours or no more than a few days) during breaks in the traffic with little or no restrictions in general movements and no effect on their distribution and abundance. Effects to terrestrial mammals would be local, within 1-2 kilometers [0.62-1.2 miles] of the pipeline-road corridor. As with construction of the oil pipeline, the construction of the gas pipeline would alter only a small fraction of caribou, muskox, grizzly bear, and arctic fox habitat.

Conclusion: The level of effects on caribou, muskoxen, grizzly bears, and arctic foxes resulting from natural gas development and production would likely be local (within 1-2 kilometers [0.62-1.2 miles] of the pipeline-road corridor) and have no effect on their distribution and abundance.

IV.H.9. Vegetation and Wetlands

The most likely effects of natural gas development and production on vegetation-wetlands would come from construction activities associated with installing the onshore part of the pipeline systems that connects the production platforms with the onshore-processing facility. Effects to vegetation would be local, within 1-2 kilometers [0.62-1.2 miles] of the pipeline-road corridor. Onshore, the gas pipelines would run parallel to the oil pipelines and would be serviced by the same roads. The gas pipelines probably would be buried. As with construction of the oil pipeline, the construction of the gas pipeline would alter only a small fraction of vegetation-wetland tundra habitat on the North Slope.

Conclusion: The level of effects on vegetation-wetlands resulting from natural gas development and production would likely be local (within 1-2 kilometers [0.62-1.2 miles] of the pipeline-road corridor) and have no effect on the distribution and abundance of vegetation-wetlands on the North Slope.

IV.H.10. Economy

The construction and operation of a large-diameter pipeline from production platforms(s) to onshore and a pipeline from the Prudhoe Bay area to Valdez would generate employment, taxes, and royalty revenues. During 5 years of construction, employment will peak at 7,200 direct jobs and 3,300 indirect and induced jobs, for a total of 10,500 jobs annually. During operations, employment would be 550 direct jobs and 1,250 indirect and induced jobs annually, for a total of 1,800 jobs annually. During production, operations will generate $188 million in property tax (for all local jurisdictions and the State), $64 million State severance tax, and $125 million royalty revenue annually. We derive these figures from the projections for the Northeast National Petroleum Reserve-Alaska final Integrated Agency Plan/EIS cumulative-case analysis (USDOI, Bureau of Land Management and MMS, 1998). This in turn derives the figures for the Trans-Alaska Gas System as analyzed in USDOI, Bureau of Land Management, and U.S. Army Corps of Engineers (1988).

Conclusion. During 5 years of construction, employment will peak at 10,500 direct, indirect, and induced jobs annually. During operations, employment would be 1,800 direct, indirect, and induced jobs annually. During production, operations will generate $188 million in property tax (for all local jurisdictions and the State), $64 million State severance tax, and $125 million royalty revenue annually.

IV.H.11. Subsistence-Harvest Patterns

Effects of natural gas development and production on the subsistence resources and harvest patterns could be caused by gas blowouts; installing offshore pipelines and gas-production systems; drilling gas-production wells; installing onshore pipelines and a gas-processing facility; marine-, surface-, and air-traffic noise and disturbance; construction activities; and growth in the local economy, population, and employment.

A natural gas accident could be caused by a gas-well blowout or a pipeline rupture. If such an unlikely event occurred, a gas-well blowout probably would not persist for more than 1 day and would release perhaps 20 metric tons of gas hydrocarbons in a hazardous plume of gas, which could extend downwind from the source for about a kilometer but would quickly dissipate once the blowout stopped. The amount of volatile organic compounds released by such a blowout would be less than what evaporates from an oil spill greater than or equal to 1,000 barrels. The effects of gas line construction activities with the development and production of natural gas fields are expected to occur during the winter and would have little effect on bowhead whales. If a natural gas blowout occurred, some bowhead whales in the immediate vicinity of the blowout could be injured or killed. Emissions of gaseous hydrocarbons from the blowout would be hazardous to any organisms exposed to high concentrations. However, the blowout would likely not persist more than a day and gaseous hydrocarbons would be dispersed very rapidly from the blowout site. It is likely that few bowhead whales would be affected by the emissions produced from a blowout. Effects of natural gas development on seals, polar bears, and beluga and gray whales are likely to be short term from noise and disturbance from construction activities and local–within about 1 mile of blowouts. The level of effects on caribou, muskoxen, grizzly bears, and arctic foxes resulting from natural gas development and production is expected to be local, within 0.62-1.2 miles of the pipeline road corridor and have no effect on their distribution and abundance.

If a natural gas blowout occurred, some fish in the immediate vicinity might be killed, but, in general, very few fish are likely to be affected by a blowout, and any effects would not be measurable at the population. Development and production of natural gas fields likely would have temporary, nonlethal effects on marine and coastal birds. Most effects would result from air and vessel traffic associated with construction and operation of production platforms and offshore-pipeline installation during the open-water season. Most birds are likely to avoid the sites of these activities by altering their routes of movement in the vicinity. Much of the construction activity associated with the development and production of natural gas fields may occur during the winter and would have little effect on migratory birds, but could destroy a small amount of foraging habitat. In the event of a natural gas blowout, some birds in the immediate vicinity of the event could be injured or killed, but it is likely that few marine and coastal birds would be affected by these hydrocarbons emissions.

Conclusion: Because effects on primary subsistence resources from gas line construction and a blowout event are expected to be local and short-term, effects on subsistence-harvest patterns are expected to be periodic and not curtail the overall seasonal subsistence harvest.

IV.H.12. Sociocultural Systems

Because subsistence harvests would not be curtailed by gas-pipeline construction or by the short-term effects of a gas blowout, effects could periodically disrupt but not displace ongoing social systems, community activities, and traditional practices for harvesting, sharing, and processing subsistence resources.

IV.H.13. Archaeological resources

The most likely effects of natural gas development and production on archaeological resources would come from construction activities associated with installing the offshore and onshore part of the pipeline systems. Offshore, a trench would have to be excavated for the buried pipeline. Onshore, the gas pipelines would run parallel to the oil pipelines and would be serviced by the same roads, limiting possible effects to within 1-2 kilometers (0.62-1.2 miles). Gas pipelines probably would be buried.

Conclusion. Offshore, trenching activities may have a potential effect on archaeological resources, which would be mitigated by predevelopment marine archaeological surveys. Onshore, effects of natural gas development and production, is expected to be local of the pipeline-road corridor) but, where pipe is buried, there are potential effects on prehistoric archaeological resources.

IV.H.14. Land Use Plans and Coastal Management Programs

Natural gas development and production are assumed to occur in the same area and follow the same transportation routes as oil production. Effects would be comparable to those addressed in Section IV.C. The greatest potential for conflict relates to subsistence resources and access. Any effects to subsistence resources and access to subsistence resources would be periodic, short-term, and local and not curtail the overall seasonal subsistence harvest.

Conclusion. No conflicts with existing land use plans and coastal management programs are anticipated.

IV.H.15. Air Quality

Emissions from gas production would be primarily nitrogen oxides, due to increased power requirements for turbines for gas compression. The emissions from any gas blowouts would be principally volatile organic compounds, which, if not burned, would be dissipated very quickly by winds. This would result in minimal effects on air quality.

Development drilling and platform and pipeline installations associated with natural gas resources would result in additional emissions of carbon monoxide, sulfur dioxide, nitrogen oxides, and volatile organic compounds. These emissions would be produced from the same sources producing emissions in oil development and oil production activities. During the construction phase, emissions would be higher because of gas pipelines that would be installed. Also, during the production phase, there would be increased power requirements and, therefore, increased emissions, from compressors needed to pipe the natural gas to shore. These emissions would be offset to a certain extent by the reduced need to reinject produced gas into the formation.

Conclusion. Only a minimal effect on air quality would be expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations onshore due to exploration, development, and production activities, or to accidental emissions, would not be sufficient to harm vegetation.

IV.H.16. Environmental Justice

Because subsistence harvests would not be curtailed by gas-pipeline construction or by the short-term effects of a gas blowout, and because ongoing social systems, community activities, and traditional practices for harvesting, sharing, and processing subsistence might be periodically disrupted but not displaced, effects on environmental justice are not expected to produce significant effects on the Inupiat people or reach the disproportionate, high adverse effects threshold.

IV.I. Low-Probability, Very Large Oil Spill

Introduction: A very large oil spill is an issue of concern to everyone. We define a very large oil spill as greater than or equal to 150,000 barrels of oil. A very large oil spill is a low-probability event with the potential for very high effects. In this section, we analyze the potential effects to resources from an oil spill in the nearshore Beaufort Sea. Very large spills happen infrequently, and we have limited historical data for use in our statistical analysis and predictive efforts.

The largest spill from a blowout in Federal waters is 80,000 barrels. One other spill greater than 50,000 barrels has happened since offshore drilling began in the United States. Because there are no spills greater than 150,000 barrels in U.S. waters, we must look elsewhere for data on spills of that size. Therefore, we use worldwide historical spill data to estimate the chance of very large spills occurring. The spill information we use is based on spills from other countries that do not have the regulatory standards that are enforced on the OCS. In addition, some drilling practices used elsewhere either are not practiced here or are against OCS regulations.

Internationally from 1979 through 2000, five oil-well blowouts greater than or equal to 10 million gallons (238,000 barrels) have occurred (*, International Oil Spill Statistics; Oil Spill Intelligence Report,* 1996; Cutter Information Corp., 1997; DeCola, 2001). Five of the blowouts greater than 10 million gallons mostly were the result of either war or drilling practices that oil companies do not now use and may not use under MMS regulations in the United States. During this same time period, there were roughly 470,506 billion barrels of oil produced worldwide (British Petroleum, 2001; *Statistical Review of World Energy,* 1997, and earlier issues). These data provide a rate of about 0.01 blowouts greater than or equal to 10 million gallons per billion barrels produced. If this rate is applied to Alternative I for Sale 186, the estimated probability of one or more oil spills of 10 million gallons (238,000 barrels) is 0.0046, or 0.5%.

S.L. Ross Environmental Research Ltd. (1998) calculated the chance of an extremely large oil spill (greater than 150,000 barrels) from a blowout for an average of the Northstar and Liberty projects using worldwide spill frequencies similar to the previous paragraph.

Scandpower (2001) recently completed a blowout-frequency assessment of Northstar. This analysis modified statistical blowout frequencies to reflect specific conditions and operating systems at Northstar for the drilling process. The estimated blowout frequency for drilling into the oil-bearing zone and spilling greater than 130,000 barrels is 9.4×10^{-7}.

The State of Alaska prohibits the drilling of new wells or sidetracks from existing wells into major liquid-hydrocarbon zones at its drill sites during the defined period of broken ice and open water (BPXA, 2001). This period begins on June 13 of each year and ends with the presence of 18 inches of continuous ice cover for one-half mile in all directions from the Northstar Island. This drilling moratorium eliminates the environmental effects associated with a well blowout during drilling operations in the Beaufort Sea during broken-ice or open-water conditions.

Although the drilling prohibition during broken ice and open water reduces the chance of a blowout, it is not completely eliminated during the time the field is producing oil and, as noted in the following section, the State of Alaska requires the greatest possible discharge that could occur from a blowout as a planning standard. Thus, this EIS evaluates the potential effects of a very large oil spill.

Effects to Resources from a 180,000-Barrel Blowout Oil Spill: We analyze the potential effects of a very large, but extremely unlikely, oil spill of 180,000 barrels from the nearshore area on sensitive resources in the Beaufort Sea region. We derive this spill size from previous development and production plans in the Beaufort Sea that estimate the greatest possible discharge. For the Northstar and Liberty development projects, BPXA estimates a 15,000-barrel flow rate per day for 15 days, totaling 225,000 barrels. Computer model runs simulating a blowout by S.L. Ross Environmental Research Ltd., Dickens and Associates, and Vaudrey and Associates (1998) estimate that 20% of the oil would evaporate in the air; this amount equals 45,000 barrels. An additional 3,400 barrels remain on the gravel island (BPXA, 1999). A total of 176,600 barrels reaches the water or ice. For purposes of analysis, we round this number to 180,000 barrels.

IV.I.1. Blowout Assumptions

In the extremely unlikely event of a large blowout, we assume it would occur in the nearshore area and release crude oil into the environment for 15 days. The three general environments into which the oil could discharge are solid ice, broken ice, and open water.

The following blowout assumptions are from modeling (S.L. Ross Environmental Research Ltd., Dickens and Associates, and Vaudrey and Associates, 1998). A blowout spill rises into the air at an average rate of 500 barrels per hour (BPXA, 2000b). Oil droplets fall to the gravel island and surrounding area. Approximately 20% of the 225,000 barrels evaporates into the air, leaving 180,000 barrels on the island's surface and surrounding area (Tables IV.I-1 and IV.I-2).

Within 15 days from the start of the spill:

- 3,400 barrels remain on the gravel island,
- 86,600 barrels drain from the island into the environment, and
- 90,000 barrels fall to the surrounding environment at a rate of 10,000-12,000 barrels a day.

Of the oil falling to the surrounding environment:

- 84% of the oil falls out approximately 4,500 feet from the source within a 975-foot wide area, and
- 16% of the oil falls out approximately 13,000 feet from the source within a 2,000-foot wide area.

IV.I.1.a. Behavior of a Blowout Oil Spill in Solid Ice

Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water as long as the ice was solid. Alaska Clean Seas estimates it would take 122 days to recover the oil from the blowout after the flow is stopped (Alaska Clean Seas, 1998).

There would be little or no change in the oil's physical properties at very low temperatures and when buried under a snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface. Table IV.I-3 shows the fate of oil on solid ice.

IV.I.1.b. Behavior of a Spill in Broken Ice

Broken ice occurs in the Beaufort Sea during fall freezeup and spring breakup. This scenario assumes that oil would drain from the gravel island into broken ice and would fall to the broken ice in a scattered pattern. The ice would contain the oil somewhat and reduce spreading. Unless the oil is frozen into the ice, the evaporation rate would not change. Dispersion and emulsification rates are lower in broken ice than in open water.

IV.I.1.b(1) Fall Freezeup through Meltout

During fall freezeup, the oil would freeze into the grease ice and slush before ice sheeting occurs. Winds and storms could break up and disperse the ice and oil until the next freezing cycle. These freezing cycles can be hours or days. Before freezeup, the oil could move at a rate of 5 nautical miles per day (S.L. Ross Environmental Research Ltd., Dickens and Associates, and Vaudrey and Associates, 1998).

In late spring and summer, the unweathered oil would melt out of the ice at different rates, depending on whether it is encapsulated in multiyear or first-year ice and when the oil was frozen into the ice. In first-year ice, most of the oil spilled at any one time would percolate up to the ice surface over about a 10-day period. About mid-July, the oil pools would drain into the water among the floes of the opening ice pack. Thus, in first-year ice, oil would be pooled on the ice surface for up to 30 days before being discharged from the ice surface to the water surface. The pools on the ice surface would concentrate the oil, but only to about 2 millimeters thick, allowing evaporation of 5% of the oil, the part of the oil composed of the lighter, more toxic components of the crude. By the time the oil is released from the melt pools on the ice surface, evaporation has almost stopped, with only an additional 4% of the spilled oil evaporating during an additional 30 days on the water. Tables IV.I-4 and IV.I-5 show specific estimates of the fate of a spill into broken ice.

IV.I.1.b(2) Spring Breakup through Meltout

For purposes of analysis, we assume that a spill during spring breakup would have the same effects as an open-water spill. At spring breakup, the ice concentrations are variable. With high concentrations of ice, oil would spread between icefloes. As the ice concentrations eventually decrease to less than three-tenths, the oil on the water behaves as an open-water spill, with local oil patches temporarily trapped by the wind against floes. Oil that is on the icefloes would move with the ice as it responds to nearshore currents (S.L. Ross Environmental Research Ltd., 1998). Table IV.I-6a shows the specific estimates of the fate of a spring spill into broken ice. Table IV.I-6b shows our estimate of the length of coastline oiled.

IV.I.1.c. Behavior of Spills in Open Water

This scenario assumes oil would drain from the gravel island into open water. Oil also would fall to open water adjacent to the gravel island. The oil would move with the currents and the winds. The fate of an open-water spill is shown in Tables IV.I-7 and IV.I-8. Table IV.I-6b shows our estimate of the length of coastline oiled.

IV.I.1.d. The Chance of an Oil Spill Contacting Resources of Concern

We estimate how much oil would reach specific shorelines or other environmental resources from the conditional probabilities for a spill from the spill areas LA10 and LA12 (Map A-4b). For a full discussion of the Oil-Spill-Risk Analysis model and how we derive the oil-spill modeling simulations and supporting tables, see Appendix A.

Tables IV.I-9a, IV.I-9b, and IV.I-9c summarize the conditional probabilities that a spill starting at spill areas LA10 and LA12would contact individual land segments or environmental resources within 1, 3, 10, 30, and 360 days during summer or winter.

IV.I.2. Analysis of Effects to Each Resource from a 180,000-Barrel Blowout Oil Spill

IV.I.2.a. Water Quality

Hydrocarbon contamination from a very large spill during summer could exceed the 1.5 parts per million acute toxic criterion during the first several days in an area of several hundred square kilometers (a hundred square miles) (USDOI, MMS, Alaska OCS Region, 2002a:Section IX.A.l). The contamination could exceed 0.015 parts per million chronic criterion for several months in an area over ten thousand square kilometers (about 5,000 square miles). This amount of oil in the water with broken ice could exceed the 1.5-parts per million acute-toxic criterion for more than 3 days in an area of about 100 square kilometers (less than 50 square miles) and the 0.015-parts per million chronic criterion for several months in an area of about 8,000 square kilometers (3,000 square miles). In other words, a large spill of crude oil would affect water quality by increasing the concentration of hydrocarbons in the water column in a large area to levels that greatly exceed background concentrations. However, the chance of such a large spill occurring is extremely low.

The contamination estimates may represent an upper range of concentrations of dispersed oil reached during the first several days following a large spill. Both the summer and broken-ice concentrations of oil that are estimated to be dispersed in the water column after 30 days, 0.11 and 0.14 parts per million, respectively, are greater than petroleum hydrocarbons concentrations of 0.001-0.006 parts per million that were observed in Prince William Sound 21-41 days after the *Exxon Valdez* oil spill. The estimated concentration of dispersed oil in the water 30 days after both the summer and broken-ice/meltout spills is greater than 0.015 parts per million and indicates a relatively long period of time, perhaps several months or more, before dilution of the dispersed oil reduces the concentrations below the chronic criterion. Applicable ambient-water-quality standards for marine waters of the State of Alaska are noted in Section III.C.2.l.of the Liberty EIS (USDOI, MMS, Alaska OCS Region, 2002a).

Oil-spill-cleanup activities are not expected to affect water quality by adding any new or additional substances to the water. Removing oil from the environment would help reduce the amount of oil that gets dispersed into the water. However, the amount of oil removed depends on environmental conditions during cleanup operations. As the oil is removed, the amount contributing oil to dispersion decreases and, as the oil is dispersed, the concentration decreases. The effect of removing oil would be to reduce the concentration in the water relative to the amounts estimated in the above analysis for a given time interval or given area.

IV.I.2.b. Lower Trophic-Level Organisms

This analysis considers the effects of an assumed 180,000-barrel oil spill into offshore waters on lower trophic-level organisms during the summer and winter months. The specific effects of petroleum on lower trophic-level organisms are discussed under the Alternative I for Sales 186, 195 and 202 (Section IV.C.2). The spill would adversely affect some lower trophic-level organisms by exposing them to petroleum-based hydrocarbons.

IV.I.2.b(1) Kelp and Other Marine Plants

Large-scale effects on marine plants from oil spills have been observed in the intertidal and subtidal zones of other regions. Because of the predominance of shorefast ice in the affected area, there is no resident marine flora in waters less than 6 feet deep; therefore, there would be no effects. The oil spill also is not expected to have any measurable effect on subtidal marine plants (such as those of the Boulder Patch kelp habitat), because they live below the zone where toxic concentrations of oil can reach them.

IV.I.2.b(2) Coastal and Benthic Marine Invertebrates

Large-scale effects on marine invertebrates from oil spills have been observed in the intertidal and subtidal zones of other regions. There are limited intertidal and nearshore subtidal zones in the Beaufort Sea. Instead, it is a highly disturbed area that is seasonally recolonized by a small number of opportunistic faunas during the summer (about 3 months). The nearshore area does support mobile epibenthic invertebrates (amphipods, mysids, copepods, clams, snails, crab, and shrimp), which are fed on by vertebrate consumers during the summer. If contacted by surface oil, these invertebrates are likely to die or be sublethally affected.

If oil enters the coastal waters, the recovery of seasonal benthic invertebrates would be expected within 2 months, after water quality in the nearshore water column returns to prespill conditions and other opportunistic marine invertebrates move into the area. Oil incorporated by wave action into shoreline bottom sediments is expected to remain there for several years. In the areas where bottom sediments are heavily oiled, some lethal and sublethal effects could occur each summer, when seasonal benthic invertebrates return to those areas. However, this is not expected to affect a measurable percentage of the seasonal benthic invertebrate population in Stefansson Sound. The recovery of resident benthic invertebrates would be expected within 5 years, but it could require up to 10 years in areas where water circulation is significantly reduced. Oil mixed into shoreline bottom sediments would have the greatest effect on resident benthic fauna, because they are not seasonally restocked from deeper waters as are seasonal fauna. Subtidal marine organisms deeper than 2 meters (including those of the Boulder Patch area) are not likely to be affected, because they live below the zone where toxic hydrocarbon concentrations can reach them.

Other lower trophic-level organisms likely to be contacted by oil in the water column are the plankton. These include phytoplankton; zooplankton (copepods, euphausiids, mysids, and amphipods); and the larval stages of marine invertebrates such as annelids, mollusks, and crustaceans. Because of similarities in habitat use and distribution, the percentage of marine-invertebrate larva contacted by floating or dispersed oil is likely to be similar to that expected for plankton. The method of assessment is the same as the one used in the Sale 170 EIS (USDOI, MMS, 1998:IV-B-8) and Liberty EIS (USDOI, MMS, Alaska OCS Region, 2002a:Section IX.A.6.e). During the winter/spring (about 10 months), the very large oil spill probably would not have a measurable effect on plankton, because few are present during this time and oil would not be dispersed in the water column. However, effects are likely to occur during the summer when plankton is abundant.

To summarize, a very large oil spill probably would affect half of the planktonic organisms in about half of the sound, or a total of about one-quarter of the Stefansson Sound plankton. Because of their wide distribution, large numbers, and rapid rate of regeneration (12 hours), there would be only a temporary, local effect on the planktonic community. The recovery of the community would be complete within 1-2 weeks (the estimated flushing time for Stefansson Sound).

IV.I.2.b(3) Oil-Spill Prevention and Response

Spill-response manuals, such as the Alaska Clean Seas technical manuals, identify sensitive sections of the Beaufort Sea coastline on which oil might persist for a decade, including some within the project area (Alaska Clean Seas, 1998:Index Sheets 1 and 2). The most sensitive types of shoreline, such as river deltas and sheltered lagoons, are listed clearly in the manual as "areas of major concern" (Alaska Clean Seas Tactic W-6). The manual also describes several tactics for protecting sensitive sections of the coastline. Intertidal and exclusion booms would be used along the shoreline in marshes and inlets. Deflection booms would be used to divert oil to sections of the coast waters that are less sensitive or more suitable for oil recovery; the oil would be collected by booms and pumped by skimmers to local storage tanks. Some lower trophic-level organisms on the shorelines would be adversely affected by these and other response tactics. Use of dispersants on a spill near benthic kelp communities would mix the oil farther down into the water column and could affect the kelp community. However, the use of dispersants is not essential for spill response; their use would require further approval by the Coast Guard.

IV.I.2.c. Fishes

Due to their very low numbers and wide area of distribution, no measurable effects are expected on fishes in winter. Effects would be more likely to occur from an oil spill moving into nearshore waters in summer, where fishes concentrate to feed and migrate. Based on the Oil-Spill-Risk Analysis model (Table IV.I-9a), the nearshore areas of highest chance of contact include Land Segments 31-37. If a 180,000-barrel oil spill occurred, these land segments would have a 0.5-8% chance of being contacted in 30 days. According to Tables IV.I-6a and IV.I-6b, a 180,000-barrel oil spill would contact about 300 kilometers of coastline, which is about seven times that estimated for the 4,600-barrel oil spill associated with Alternative I for Sales 186, 195, and 202. However, the combined probability of one or more spills occurring and contacting the nearshore area is very low (less than 0.5%). If it did occur, some marine and migratory fish might be harmed or killed. The number affected would depend on the size of the area affected, the concentration of petroleum present, the time of exposure, and the stage of fish development involved (eggs, larva, and juveniles are most sensitive). If lethal concentrations were encountered, or sublethal concentrations were encountered over a long-enough period, fish mortality would be likely to occur. However, mortality due to petroleum-related spills is seldom observed outside of the laboratory environment. This is because the zone of lethal toxicity is very small and short lived under a spill, and fishes in the immediate area typically avoid that zone. Mortality would be expected only in cases where fishes were somehow trapped in a lethal concentration and could not escape. Because this would be very unlikely outside of the laboratory environment, little to no mortality due to lethal concentrations would be expected.

If oil were to reach the shore and become buried in intertidal and/or subtidal sediments, it likely would be released back into the water column at a later time. However, the amounts of oil released in that manner are likely to be relatively small over time, and fish density in Beaufort Sea coastal waters also is relatively low most of the year. While a 180,000-barrel oil spill would be expected to affect about 300 kilometers of nearshore waters and coastline, it would be likely to have mostly sublethal effects (for example, changes in growth, feeding, fecundity, and temporary displacement) on marine and migratory fish. Juvenile fish (for example, arctic cod), which are common in the nearshore area during summer, or nearshore spawners (for example, capelin) are among those most likely to be adversely affected. Some fish in the immediate area of a spill may be killed; however, it is not expected to be a measurable effect on marine and migratory fish populations. Recovery of the number of fish harmed or killed would be expected within 10 years.

Oil-spill-cleanup activities, whether on ice or for oil entrained in the ice, are not expected to adversely affect fish populations. It is possible that a containment boom could trap some oil in a shoreline area and temporarily contaminate that area long enough to affect fishes or their food resources. In general however, reducing the amount of oil in the marine environment is expected to have a beneficial effect on fishes, because it reduces the possibility of hydrocarbons contacting them and their food resources. The extent of that benefit would depend on the actual reduction in the amount of oil contacting fish and their food resources, as compared to that of not reducing the amount of contact.

IV.I.2.d. Essential Fish Habitat

Over a 15-day period, about half to three-quarters the amount of oil from a blowout spill (about 176,600 barrels a day) would fall on the water or sea ice within 2-3 kilometers of the blowout. About 4,100 barrels likely would fall to the sediments and about 36,000 barrels likely would wash onshore along approximately half of the 900 kilometer coastline. That portion falling through the water column is expected to make salmon essential fish habitat unusable for those 30 days. Oil falling to the sediment in the estuarine habitat, especially that very shallow area used by salmon smolt adjacent to the shore, likely would have some lethal and sublethal effects on salmon prey (see IV.I.2.c - Fishes) for up to several years. Because salmon must feed within several days of entering the estuarine areas, they also could experience lethal and sublethal effects for up to several years. Oil contacting the coastline also would be likely to affect short sections of freshwater habitat in any anadromous streams contacted, possibly causing sublethal and genetic effects for one generation of salmon eggs and juveniles.

IV.I.2.e. Endangered and Threatened Species

IV.I.2.e(1) Bowhead Whales

The Oil-Spill-Risk Analysis model estimates a 35% probability (expressed as a percent chance) that a large oil spill (180,000 barrels) starting at LA10 during the summer will contact Ice/Sea Segment 4, an important bowhead whale-habitat area in the fall, within 30 days. The oil-spill model estimates a 21% chance that a large oil spill starting at LA12 during the summer will contact Ice/Sea Segment 4, an important bowhead whale-habitat area, within 30 days. During the open-water season, there would be an estimated 71,900 barrels of oil remaining in the slick after 30 days (Table IV.I-7), covering a discontinuous area of about 5,700 square kilometers (Table IV.I-8).

The oil-spill model estimates an 8% chance and a 3% chance that a large oil spill starting at LA10 and LA12, respectively, during the winter will contact Beaufort Spring Lead 10, an important bowhead whale-habitat area in the spring, within 30 days. During the broken-ice season and the solid-ice season there would be an estimated 120,900 barrels and 168,000 barrels of oil, respectively, remaining in the slick after 30 days (Table IV.I-7). These spills would cover a discontinuous area of about 3,200 square kilometers 30 days after meltout (Table IV.I-8).

The probability of oil contacting whales is likely to be considerably less than the probability of oil contacting bowhead whale habitat.

The fall migration through the Beaufort Sea generally occurs in relatively open-water conditions. The migration area is less confined than during the spring migration and whales migrate over a broader area. A spill during the open-water season would not be continuous over the entire area. It is unlikely that the spill would cause an impediment to the migration. The migrating whales could come in contact with oil, but such contact likely would be brief. In some years, bowheads have been observed feeding near shore between Point Barrow and Cape Halkett. If bowheads were feeding in that area when spilled oil was present, some of the oil could be ingested.

A major concern for bowhead whales is an oil spill that contacts the spring-lead system, where bowheads could be concentrated during their spring migration. In this large-spill scenario, a portion of the spring-lead system would be contacted by the spill after the spill melted out of the ice. However, a broken-ice or solid-ice winter spill likely would melt out in July; therefore, it is not likely that a winter spill would be melted out of the ice in time to contact the spring leads during the spring whale migration. For the fall migration, oil from a meltout spill would be somewhat weathered and the toxic hydrocarbons at least partially evaporated before the oil entered the water. As a result of the weathering, the spill would be less likely to cause respiratory distress to bowheads surfacing to breathe.

Effects of an oil spill on bowheads would be as described previously in Section IV.C.5: oiling of the skin, inhaling hydrocarbon vapors, ingesting contaminated prey, fouling of their baleen, reduced food source, displacement from feeding areas, and possibly death. The number of whales contacting spilled oil would depend on the timing and duration of the spill, ice conditions, effectiveness of cleanup and containment operations, how many whales were near the spill, and the whales' ability or inclination to avoid contact. Based on conclusions from studies presented in Section IV.C.5 that have looked at the effects of oil spills on cetaceans, exposure to spilled oil is unlikely to have serious direct effects on baleen whales. Most individuals exposed to spilled oil are expected to experience temporary, nonlethal effects. Exposure of bowhead whales to spilled oil could result in lethal effects to some individuals.

Conclusion: Based on conclusions from studies that have looked at the effects of oil spills on cetaceans, exposure to spilled oil is unlikely to have serious direct effects on baleen whales. Most individuals exposed to spilled oil are expected to experience temporary, nonlethal effects from oiling of the skin, inhaling hydrocarbon vapors, ingesting contaminated prey, fouling of their baleen, reduced food source, and displacement from feeding areas. Exposure of bowhead whales to spilled oil could result in lethal effects to some individuals.

IV.I.2.e(2) Spectacled and Steller's Eiders

IV.I.2.e(2)(a) Effects of a Blowout Oil Spill on Spectacled and Steller's Eiders

From early June to early July (males) and late June to early September (failed females or females with young), flocks of spectacled eiders may be present in coastal lagoons and offshore waters (Fischer, Tiplady, and Larned, 2002; Fisher, 2002; Troy Ecological Research Assocs., 1995b, 1999); in late summer females with fledged young move from coastal habitats to nearshore or offshore areas. Realistic values for densities of spectacled eiders present in these areas that would allow the estimation of potential mortality from oil-spill contact are unavailable. However, in the unlikely event of a 180,000-barrel spill covering a discontinuous area of 5,700 square kilometers after 30 days (Table IV.I-8), some of these flocks, or females with young along the 275-300 kilometers (100-130 miles [Table IV.I-6]) of coast (maximum distance is equivalent approximately to the coastline from Camden Bay to western Harrison Bay) where oil is likely to contact or become stranded, are expected to be contacted and may experience substantial mortality. A spill occurring in winter and released from the ice in spring could contact eiders in open water near river deltas. For the spectacled eider, with a relatively small regional population and low productivity, the loss that could result from such a spill of perhaps tens of locally nesting individuals plus an unknown number of migrants would represent a significant loss. Because there is no clear population trend in the coastal plain population, and there is a lack of certain data required to model population fluctuations, an estimate of recovery time from such a loss currently would be speculative. Also, losses may be difficult to separate from natural variation in population numbers (see the discussion in Section IV.C.5.b(1)(b)3)). If a spill of this size occurred in August or September, there is a potential for small numbers of Steller's eiders that nest on the western Arctic Coastal Plain to be contacted while staging in the western Beaufort Sea. This could represent a substantial proportion of the coastal plain population. Little information is available concerning presence, timing, or numbers in marine waters (but see Map 9; Fischer, 2002; Fischer, Tiplady, and Larned, 2002; Larned, et al., 2001; Martin, 2001, pers. commun.; Quakenbush, et al., 1995).

Oil contacting or mixed into bottom sediments and mudflat areas (an estimated 4,100 barrels [Table IV.I-4]), or affecting species-rich foraging areas such as boulder patches, is expected to kill substantial numbers of eider food organisms. It is difficult to determine the actual effect that such indirect effects as a decline in food organisms would have on bird populations. Decreased food availability might adversely affect the ability of juvenile birds to develop as rapidly as they would normally, decrease adult fitness, or might delay the accumulation of fat reserves for migration. Any mortality from such indirect effects would be additive to the loss of oiled individuals.

IV.Ii.2.e(2)(b) Effects of Oil-Spill Prevention and Response

IV.I.2.e(2)(b)1) Blowout During Open-Water Conditions

Despite the potential for effective spill containment, recovery, and cleanup under ideal weather conditions, these may not exist during a spill incident, and some eider habitats are likely to be contacted by oil. Most detections of satellite-tagged spectacled eiders have been in or offshore of Simpson Lagoon and west. The Oil-Spill-Risk Analysis model estimates the chance of contact by spilled oil within 30 days in summer in nearshore or offshore areas ranges up to 55%; along the shoreline contact probability is less than 8% (Tables IV.I-9a and IV.I-9c). These areas would need to be surveyed for eider presence to plan an adequate response strategy. If the spill is not contained before reaching these areas, the most effective response may involve hazing. The probability of a large spill occurring is extremely small.

Although spectacled eiders apparently spend little time in nearshore coastal habitats, females with broods may occupy them briefly before moving to offshore staging areas. Containment, recovery, and cleanup activities for a large spill are expected to involve hundreds of workers and numerous boats, aircraft, and onshore vehicles operating over an extensive area for more than 1 year. The presence of such a workforce is likely to act as a general hazing factor, displacing any eiders from the immediate area of activity, perhaps within a few kilometers, which potentially might be viewed as a positive result, given birds' extreme vulnerability to oil in the environment. If a reliable system of locating eiders in a specific area can be devised, specific birds or groups in danger of oil contact could be targeted with specific hazing tactics.

Currently, no important specific foraging areas for eiders are identified, although numerous satellite transmitter locations and visual observations during aerial surveys suggest that in and offshore of Harrison Bay may be an important area. Because spectacled eiders nest at low density, and there appears to be little tendency for them to nest near the coast (Troy Ecological Research Assocs., 1999), disturbance of nesting eiders by onshore cleanup activities is not expected to result in significant increases in nest abandonment or loss of eggs or young to predators or exposure to weather, or overall decreases in productivity. Displacement by cleanup activity of females with broods from coastal habitats may have a negative effect, if it prematurely forces them into the offshore marine environment where the high salinity could increase stress on the ducklings, which have a relatively low tolerance to salt (USDOI, Fish and Wildlife Service, 1996). Helicopter support traffic and human presence probably would be the most disturbing factors associated with oil-spill-cleanup activity. If their presence forces eiders from a marine area where oil contact is imminent, it may be considered a positive factor. However, overland flights and off-road personnel activity during the nesting season may displace females from their nests or broods and result in egg or duckling losses from predation or exposure.

Prompt containment and removal of oil from offshore areas, accompanied by hazing tactics targeting high-use areas, is likely to result in a substantial reduction of spectacled eider mortality from a large oil spill. Cleanup also would decrease the amount of oil available for uptake by bottom-dwelling organisms that are the principal food of eiders. This could reduce the potential for oil uptake by eiders and associated adverse physiological side effects, although the benefit of this indirect effect on the eider population cannot be quantified at present.

IV.I.2.e(2)(b)2) Blowout During Broken-Ice Conditions

Containment and oil recovery following a blowout spill that enters the marine environment under broken-ice conditions at meltout or freezeup is expected to be less effective than for an open-water spill. Although under these conditions the area covered by the spill would be smaller than a spill in open water (3,200 versus 5,700 square kilometers [Tables IV.I-5 and IV.I-8]), spectacled eiders are not expected to occupy broken ice in either period, unless areas of open water are available. Many arriving spring migrants likely would occupy open overflow areas off river mouths that are available early and are in the vicinity of nesting areas; the greatest benefit of spill cleanup may result from containment and cleanup in such areas. In this season, the hazing effect of cleanup activity or actively hazing birds out of areas that oil is expected to enter may be counterproductive, because there are few alternative habitats that flushed birds can occupy.

If most spectacled eiders arrive in the area via overland routes (Troy Ecological Research Assocs., 1999), the benefit of spill containment and cleanup would be minimal, until they begin reentering the marine environment following the breeding period. By this time, the oil would have weathered likely would have become a decreasing hazard for plumage fouling. Indirect adverse effects resulting from the intake of contaminated prey organisms may be higher under broken-ice than open-water conditions, because reduced cleanup capability would provide a longer interval for exposure and uptake by such organisms. Entrapment of large quantities of oil in coastal marsh and adjacent habitats could present a hazard to departing males following breeding and females with young following nesting as they move to offshore waters. In fall, spectacled eiders are not likely to be present in numbers beyond late September, and oil present in broken ice at this time likely would not contact eiders.

Conclusions for Spectacled and Steller's Eiders. The 180,000-barrel blowout oil spill in open water assumed for this analysis is expected to cause spectacled eider mortality, if females with recently fledged young contact stranded oil in coastal habitats, or flocks of adult eiders or females with young feeding in lagoons and offshore waters are contacted by a spill sweeping over thousands of square kilometers. A winter spill released from the ice in spring could contact eiders concentrated in open water of river deltas. Substantial mortality that could result from such a large spill would represent a significant loss for the relatively small Arctic Coastal Plain spectacled eider population, requiring many generations for recovery. Recovery is not likely to occur while the regional population is in declining status. Any mortality, or decreased fitness or productivity from indirect effects such as decreased availability of food organisms or physiological effects from oil ingestion would be additive to the loss of oiled individuals. Although Fish and Wildlife Service survey data do not show a significant decline in the coastal plain spectacled eider population, the potential exists for a significant adverse effect from an oil spill on this regional population. Mortality of a few Steller's eiders also would represent a significant loss to its small regional population.

IV.I.2.f. Marine and Coastal Birds

IV.I.2.f(1) Effects of a Blowout Oil Spill on Marine and Coastal Birds

In mid- to late summer, up to 3,200 brant, 2,000 lesser snow geese, tens of tundra swans, and thousands of shorebirds are present in Beaufort Sea shoreline habitats; many tens of thousands of long-tailed ducks, large numbers of king and common eiders and other waterfowl, and substantial numbers of seabirds are present in coastal lagoons and offshore waters (Fisher, 2002; Fischer, Tiplady, and Larned, 2002; Johnson, 1994a,b; Johnson and Gazey, 1992; Johnson and Noel, 1996; Larned, et al., 2001; Noel, Johnson, and Wainwright, 2000; Noel and Johnson, 1996; Stickney and Ritchie, 1996; Stickney et al., 1994; Troy, 1995). A spill during this period could result in mortality exceeding a few thousand individuals, if broodrearing waterfowl or shorebirds contact stranded oil along a substantial proportion of the estimated 275-300 kilometers (100-130 miles [Table IV.I-6]) of affected shoreline (maximum distance is equivalent approximately to the coastline from Camden Bay to western Harrison Bay). In lagoon habitats, long-tailed duck densities averaging 40-275 birds per square kilometer (Noel, Johnson, and Wainwright, 2000; Stehn and Platte, 2000) suggest that when large concentrations of molting individuals are present, tens of thousands could be contacted by a spill representing a significant loss from the regional population. Significant losses also would be experienced by postbreeding common eiders concentrated near barrier islands and in lagoons. In addition, a 180,000-barrel spill covering a discontinuous area of 5,700 square kilometers after 30 days (Table IV.I-8) would be expected to contact several other species present in substantial numbers, including the king eider, scoters, northern pintail, Pacific loon, and glaucous gull. A large spill occurring in August or September and contacting a substantial proportion of the thousands of Ross' gulls that gather east of Point Barrow to feed each fall (Divoky et al., 1988), could result in a significant loss for this species whose world population probably does not exceed 50,000. Losses resulting from any aspect of development may be difficult to separate from natural variation in population numbers (see the discussion in Section IV.C.5.b(1)(b)3)).

A spill occurring in winter and released in spring could contact loons and other migrant waterfowl concentrated in open water near river deltas. For species such as yellow-billed and red-throated loons, with relatively small populations and low productivity, this could represent a significant loss.

Oil entrained in bottom sediments and mudflat areas, or affecting species-rich foraging areas such as boulder patches, is expected to kill substantial numbers of waterfowl and shorebird food organisms. The actual effect on bird populations of such indirect effects on food organisms is difficult to determine. Presumably, decreased food availability would adversely affect the ability of young to develop as rapidly as they would normally, decrease fitness or survival, or the ability of individuals to accumulate fat reserves for migration. Any mortality from such indirect effects would be additive to the losses of oiled individuals.

IV.I.2.f(2) Effects of Oil-Spill Prevention and Response

IV.I.2.f(2)(a) Blowout During Open-Water Conditions

Despite the potential for effective spill containment, recovery, and cleanup under ideal weather conditions, these may not exist during a spill incident and some loon, waterfowl, shorebird, and seabird habitats are likely to be contacted by oil. Recent aerial surveys (Fischer, 2002; Fischer, Tiplady, and Larned, 2002; Larned, et al., 2001) recorded substantial numbers of loons, waterfowl, and seabirds from Mikkelsen Bay west to Harrison Bay and Point Barrow. In this area, the Oil-Spill-Risk Analysis model estimates that the probability of contact by spilled oil in 30 days in summer in nearshore or offshore areas ranges up to 55%; along the shoreline, the probability of contact is less than 8% (Tables IV.I-9a and IV.I-9c). Although some species exhibited concentrations in Harrison Bay and Simpson and other lagoons, as a group, this suite of species was surprisingly widespread in its offshore distribution, ranging from the coastal shoreline to 50 kilometers offshore. If a large spill is not contained before reaching these areas, the most effective response may involve hazing. The probability of a large spill occurring is extremely small.

Containment, recovery, and cleanup activities for a large spill are expected to involve hundreds of workers and numerous boats, aircraft, and onshore vehicles operating over an extensive area for more than 1 year. The presence of such a workforce is likely to act as a general hazing factor, displacing birds from the immediate area of activity, perhaps within a few kilometers, which potentially may be viewed as a positive result given the extreme vulnerability of birds to oil in the environment. If a reliable system of locating bird concentrations in a specific area can be devised, specific birds or groups in danger of oil contact could be targeted with specific hazing tactics.

Displacement of female waterfowl with broods from coastal habitats by cleanup activity may have a negative effect if it prematurely forces them into the offshore marine environment where foraging may be more difficult for the ducklings, and other stresses may increase. Disturbance of nesting sea ducks by onshore cleanup activities is not expected to significantly affect their productivity. There appears to be little tendency for most of these species to nest near the coast, where there is the highest probability of disturbance by cleanup activity. Because of low nesting density, few nesting birds are likely to be displaced and potentially lose their clutches or broods to predators or exposure to weather as a result of disturbance by cleanup operations. Helicopter support traffic and human presence probably would be the most disturbing factors associated with oil-spill-cleanup activity. If their presence forces ducks from a marine area where oil contact is imminent, it may be considered a positive factor. Lesser snow geese nesting on Howe Island, brant nesting colonies along the coast, and both species broodrearing in coastal habitats are likely to be disturbed by summer cleanup activity in nearby areas.

Prompt containment and removal of oil from offshore areas, accompanied by hazing tactics targeting high-use areas, is likely to result in a substantial reduction of sea duck and shorebird mortality from a large oil spill. Cleanup also would decrease the amount of oil available for uptake by bottom-dwelling organisms that are the principal food of sea ducks and shorebirds. This could reduce the potential for oil uptake by these species, and associated adverse physiological side effects.

IV.I.2.f(2)(b) Blowout during Broken-Ice Conditions

Containment and oil recovery following a blowout spill that enters the marine environment under broken-ice conditions at meltout or freezeup is expected to be less effective than for an open-water spill. Although under these conditions the area covered by the spill would be smaller than a spill in open water (3,200 versus 5,700 square kilometers [Tables IV.I-5 and IV.I-8]), some bird species are not expected to occupy broken ice in either period unless areas of open water are available. However, Pacific loons, long-tailed ducks, king eiders, common eiders, and glaucous gulls have been observed in small areas of open water available under these conditions (Dau and Taylor, 2000; USDOI, Fish and Wildlife Service, 2000, unpublished data). Even after spring melting provides areas of open water, most arriving spring migrants likely would occupy overflow areas off river mouths, because those are available earlier and are in the vicinity of nesting areas. The greatest benefits may result from containment and cleanup in such areas. In this season, the hazing effect of cleanup activity or actively hazing birds out of areas that oil is expected to enter may be counterproductive, because there are few alternative habitats that flushed birds can occupy. For sea ducks arriving via overland routes, the benefit of spill containment and cleanup would be minimal until they begin reentering the marine environment following breeding. By this time, the oil would have weathered and is expected to have become a decreasing plumage-fouling hazard. Indirect adverse effects resulting from intake of contaminated prey organisms may be higher under broken-ice than open-water conditions, because reduced cleanup capability would provide a longer interval for exposure and uptake by such organisms. Entrapment of large quantities of oil in coastal marsh and adjacent habitats could present a hazard to departing males following breeding and females with young following nesting as they move to offshore waters. In fall, beyond late September, most sea ducks and other waterfowl and shorebirds are not likely to be present in great numbers, and oil present in broken ice at this time may have weathered and become less of a plumage-fouling hazard. Long-tailed ducks and eiders are at risk until later in the fall than most other species.

Conclusion for Marine and Coastal Birds. A 180,000-barrel oil spill in open water assumed for this analysis is expected to result in the loss of thousands of broodrearing and young waterfowl and shorebirds if they contact stranded oil along a substantial proportion of the affected shoreline. In lagoon habitats, observed high densities of long-tailed ducks suggest that on some occasions, tens of thousands of molting individuals could be contacted by a spill sweeping over thousands of square kilometers, representing a significant loss from the regional population. Likewise, contact of substantial numbers of postbreeding common eiders in the vicinity of barrier islands or Ross' gulls in the vicinity of Point Barrow, August through September could result in significant losses. Recovery is not expected to occur while specific populations are in declining status. A winter spill entering the environment after the ice melts in the spring could contact loons and other migrant waterfowl concentrated in open water near river deltas. Any mortality, or decreased fitness or productivity from indirect effects such as decreased availability of food organisms or physiological effects from oil ingestion would be additive to the losses of oiled individuals.

IV.I.2.g. Marine Mammals (Pinnipeds, Polar Bears, and Beluga and Gray Whales)

The potential effect of a very large (pipeline) oil spill (180,000 barrels) on young seals, walrus calves, and polar bears would be short term (see discussion of the general effects of oil on these marine mammals in Section IV.C.5). Within 30 days of spill release under broken-ice conditions, about 20% (36,000 barrels) of the oil would contact coastline from about Pitt Point (Land Segment 31) east to about the Canning River Delta (Land Segment 43) (Table IV.I-9c, LA12, 30 days). A portion of the ringed seal-pupping habitat in shorefast ice could at least partially be exposed to oil-spill contamination at the end of the pupping season in June. Prior to that time, most of the oil is expected to be encapsulated in the ice.

After meltout of the oil spill in mid- to late June. The density of 0.81 ringed seals per square kilometer times the area swept by the spill (3,200 square kilometers) equals about 2,590 seals exposed to the spill during spring meltout. This number of ringed seals that would be exposed to the spill represents about 6% of the resident population of 40,000. This exposure could result in the contamination and possible death of ringed seals through inhalation and absorption of toxic hydrocarbons in the oil fouling the seals' fur. This potential loss of ringed seals could take more than one generation (4-5 years) but probably less than two generations for population recovery (about 10 years).

About 67% of the oil spill likely would contact seal and polar bear ice-front habitats offshore from about Cape Halkett east to Mikkelsen Bay (represented by Ice/Sea Segments 3-5 or ERA's 31-33 [Table IV.I-9b, LA10, 30 days]). Several thousand walruses and bearded seals and perhaps up to a maximum of 128 polar bears (assuming a very high bear density of 1 bear per 25 square kilometers and a total surface area of 3,200 square kilometers swept by the discontinuous oil slick from the 180, 000-barrel oil spill) could be exposed to the oil spill (Table IV.I-5). Assuming that all young ringed and bearded seals, and all polar bears exposed to the oil died because of absorption (through the skin), inhalation, and/or ingestion of toxic hydrocarbons in the oil, this loss could take these marine mammal populations more than one to two generations to recover (up to about 15 years). Although some beluga whales might encounter some of the spill during the spring migration and summer, few if any whales are likely to be adversely affected (loss of fewer than 20 whales with population recovery in 1 year).

Conclusion. The effect of a very large oil spill is expected to be fairly long term (1-2 generations, about 15 years) on pinnipeds and polar bears and short term (about 1 year) on beluga whales.

IV.I.2.h. Terrestrial Mammals

The potential effect of a very large pipeline oil spill (180,000 barrels) on caribou, muskoxen, grizzly bears, and arctic foxes is likely to be limited to caribou groups occurring during the spring and during the insect-relief periods in coastal waters near shorelines with extensive oil contamination. Although the oil spill is estimated to contact over 480 kilometers of shoreline and muskoxen, grizzly bears, and arctic foxes frequenting coastal areas from Pitt Point east to about the Canning River Delta, the majority of the coastline contamination would occur between Oliktok Point (Land Segment 36) east to about the Staines River delta (Land Segment 42) (Table IV.I-9c, LA12, 30 days). Caribou groups that belong to the Central Arctic, Teshekpuk Lake Herd, and Porcupine herds are the assemblages of caribou likely to encounter oil while in coastal waters or on the beaches.

Heavily oiled caribou might die from absorption and/or inhalation of toxic hydrocarbons. Several hundred caribou of the Central Arctic, Teshekpuk Lake, and Porcupine herds could die from the oil spill. Small numbers of muskoxen, grizzly bears, and arctic foxes may encounter oil and be adversely affected. Potential losses would represent a short-term effect, with populations recovering within about 1 year.

Conclusion. The effects of a very large oil spill on caribou, muskoxen, grizzly bears, and arctic foxes are expected to be short term (recovery expected within about 1 year).

IV.I.2.i. Vegetation and Wetland Habitats

Coastal wetland from about Pitt Point east to about the Canning River Delta, the majority of the coastline contamination would occur between Oliktok Point (Land Segment 36) east to about the Staines River Delta (Land Segment 42) (Table IV-I-9c, LA12, 30 days). Most of the oiled shorelines would be within and along the coast of Cape Halkett east to Milne Point area (Table IV.I-9c, LA12, 30 days Land Segments 32-37). Coastal saltmarshes located in this area would be the most oiled by the spill.

Cleanup efforts would recover some of the oil. Marshy wetland habitats could be partially rehabilitated by using fertilizers to aid in biological weathering-breakdown of the oil, but recovery would be slow due to cool temperatures in summer and the short growing season. Complete recovery of oiled coastal wetlands probably could take several decades.

IV.I.2.j. Economy

In the event a very large (180,000 barrels) oil spill occurred, it would generate approximately 3,000 cleanup jobs for 1-2 years, declining to zero by the third year following the spill. The 180,000-barrel spill is about two-thirds the size of the 240,000-barrel *Exxon Valdez* oil spill in Prince William Sound. That spill generated 10,000 cleanup-related jobs for one or two seasons that declined to zero by the fourth year following the spill. Two-thirds of 10,000 is approximately 6,500 jobs. However the Beaufort Sea, its shoreline, and current cleanup capabilities on the North Slope are different from the *Exxon Valdez* oil spill in Prince William Sound in 1989. These differences, explained in the following, would reduce the 6,500 figure by more than half, resulting in 3,000 jobs.

A blowout release occurs over an extended period of time, 15 days or more. The volume released is 14,000 barrels a day. Equipment staged on the North Slope has sufficient capacity to contain, control, and recover this amount of oil on a daily basis as required by 18 ACC 430. Personnel also are readily available on the Slope to respond almost immediately (within the first 12 hours) and begin recovery operations. The location of the spill is known. Spill-response equipment, such as exclusion boom and other response supplies, has already been positioned at key locations around the North Slope. Responders would go immediately to those locations and deploy the equipment to protect sensitive environments from contamination.

The *Exxon Valdez* release essentially was an instantaneous release of more than 240,000 barrels of oil into the environment. There was considerable delay before a response was mounted, which allowed the oil to come in contact with the shore more rapidly that it would on the North Slope.

The shoreline along the Beaufort Sea coast is different in important ways from that of Prince William Sound. The Beaufort Sea shoreline is composed primarily of sand and mud, which can readily be removed with heavy equipment, low-pressure washing, or in situ burning. Wiping down rocks along the rocky shorelines and cleaning up the heavily cobbled beaches, which predominate in Prince William Sound, required substantial labor. On the North Slope, there is a huge industrial infrastructure in place to process and dispose of collected oil and wastes as generated, thereby reducing personnel required for waste management.

A very large oil spill could adversely impact the subsistence lifestyle of the North Slope Borough economy. Because a significant segment of the Borough's economy depends on subsistence resources, a loss of those resources would translate into a substantial decline in noncash household income. Limited job opportunities in the villages of the North Slope Borough make substitution of market activities for nonmarket activities difficult. The exception to this would be jobs in cleanup activities, as previously described. Some residents might find work cleaning up the spilled oil.

Conclusion. In the event a very large (180,000 barrels) oil spill occurred, the subsequent cleanup would generate approximately 3,000 jobs for 1-2 years, declining to zero by the third year following the spill. Disruptions to the harvest of subsistence resources would affect the economic well-being of North Slope Borough residents primarily through the direct loss of subsistence resources. See the next subsection for the effects on subsistence-harvest patterns.

IV.C.2.k. Subsistence-Harvest Patterns

IV.C.2.k(1) Effects of a Blowout Oil Spill

The effects on subsistence resources are provided in the discussions in the previous sections. Oil-spill contact in winter could affect polar bear hunting and sealing. Bird hunting, sealing, whaling, and the ocean netting of fish could be affected by a spill during the open-water season.

Based on conditional probabilities, a very large blowout oil spill could threaten subsistence-harvest patterns, because the oil spill could contact subsistence-resource and harvest areas important to Barrow, Nuiqsut, and Kaktovik. How much oil reaches specific shorelines or other environmental resources is estimated from the conditional probabilities. A very important consideration is that this spill is both very large and of a very long duration.

We estimate how much oil would reach specific shorelines or other environmental resources from the conditional probabilities for a spill from the spill areas LA10 and LA12. For a full discussion of the Oil-Spill-Risk Analysis model and how we derive the oil-spill modeling simulations and supporting tables, see Appendix A. Tables IV.I-9a, IV.I-9b, and IV.I-9c summarize the conditional probabilities that a spill starting at spill areas LA10 and LA12 would contact individual land segments or environmental resources within 1, 3, 10, 30, and 360 days during summer or winter. For spills starting in the summer months (July through September) after 30 days, the general transport of oil from spill areas LA10 and LA12 would be to the west and north. For spills starting in the winter months (October through June) from spill areas LA10 and LA12 and melting out into open water after 360 days, the general transport of oil would be similar to the summer pattern. The Oil-Spill-Risk Analysis probabilities should be considered as the percentage of the total spill contacting a particular environmental resource area rather than how likely that contact would be.

For conditional probabilities, the oil-spill model estimates a 1-3% chance of a very large 180,000-barrel oil spill starting at LA10 contacting important Barrow ERA's 2 (Point Barrow) and 42 (Bowhead Whaling Area) within 30 days during the summer, and a 4-5% chance of contact from LA10 over a 360-day period. Land Segments 25 (Elson Lagoon), 26 (Dease Inlet), 27 (Kurgorak Bay), 28 (Cape Simpson), and 29 (Smith Bay) have a less than 0.5-1% chance of contact from a summer spill originating at LA10 for 30 days and 1-2% chance of contact for 360 days. There is a less than 0.5% chance of a very large oil spill starting at LA12 contacting important Barrow ERA's 2 (Point Barrow) and 42 (Bowhead Whaling Area) within 30 days during the summer, and a 2-3% chance of contact from LA12 over a 360-day period. Land Segments 25 (Elson Lagoon), 26 (Dease Inlet), 27 (Kurgorak Bay), 28 (Cape Simpson), and 29 (Smith Bay) have a less than 0.5-% chance of contact from a summer spill originating at LA12 for 30 days and 1-2% chance of contact for 360 days.

Winter contact percentages for the same environmental resources areas mentioned for the summer spill generally are less. For a 30-day period, they are less than 0.5% starting at LA10, and 2-3% over a 360-day period. The same land segments as listed for the summer spill have a less than 0.5% chance of contact within 30 days, and a 1-2% chance of contact within 360 days. Starting at LA12, for a 30-day period, contact percentages for the same environmental resource areas are less than 0.5%, and 2-3% over a 360-day period. The same land segments have a less than 0.5% chance of contact within 30 days, and a 1-3% chance of contact within 360 days.

The oil-spill model estimates a 1-23% chance of a very large spill starting at LA10 contacting important Nuiqsut ERA's 3 (Thetis, Jones, and Spy islands), 4 (Cottle and Return islands), 5 (Reindeer Island), 6 (Cross Island Vicinity), 10 (Tigvariak Island), 12 (Flaxman Island/Brownlow Point), 43 (Cross Island Whaling Area), and 69 (Harrison Bay/Colville Delta) within 30 days during the summer, and a 1-26% chance of contact from LA10 over a 360-day period. Land Segments 35 (Colville River Delta), 36 (Oliktok Point), 37 (Milne Point), and 38 (Kuparuk River) have a 2-7% chance of contact from a summer spill originating at LA10 for 30 days and 3-8% chance of contact for 360 days. There is a less than 1-40% chance of a very large spill starting at LA12 contacting ERA's 3, 4, 5, 6, 10, 12, 43, and 69 within 30 days during the summer, and a 1-41% chance of contact from LA12 over a 360-day period. Land Segments 35, 36, 37, and 38 have a 1-6% chance of contact from a spill originating at LA12 for 30 days and a 3-8% chance of contact for 360 days. Land segments from the Colville River Delta to Bullen Point and Tigvariak Island include areas historically used by Nuiqsut subsistence hunters to harvest caribou, waterfowl, marine fish, polar bears, and small furbearers. This is not an area of high subsistence use at the present time. More recently, hunting appears to take place nearer to the community, and onshore areas of primary importance on the Colville River Delta.

Starting at LA10, winter contact percentages for the same environmental resource areas as mentioned for the summer spill for a 30-day period, range from less than 0.5-3%, and less than 0.5-20% over a 360-day period. The same land segments as for the summer spill have a less than 0.5-1% chance of contact within 30 days, and a 1-6% chance of contact within 360 days. Starting at LA12, for a 30-day period, contact percentages for the same environmental resource areas are less than 0.5%, and 2-3% over a 360-day period. The same land segments have a less than 0.5-1% chance of contact within 30 days and a 2-6% chance of contact within 360 days.

Environmental resource areas for Kaktovik contain crucial harvest areas for caribou, waterfowl, fish, and seals. The oil-spill model estimates a less than 0.5-1% chance of a very large oil spill starting at LA10 contacting important Kaktovik ERA's 12 (Flaxman Island/Brownlow Point), 16 (Jago Spit Area), and 44 (Kaktovik Whaling Area) within 30 days during the summer, and a 1% chance of contact from LA10 over a 360-day period. Land Segments 42 (Point Hopson), 43 (Brownlow Point), 46 (Arey Island/Barter Island), 47 (Kaktovik), 48 (Griffin Point), 49 (Beaufort Lagoon), and 50 (Icy Reef) have a less than 0.5% chance of contact from a summer spill originating at LA10 for 30 days and less than 0.5-1% chance of contact for 360 days. There is a 1-3% chance of a very large oil spill starting at LA12 contacting ERA's 12, 16, and 44 within 30 days during the summer, and a 2-4% chance of contact from LA12 over a 360-day period. Land Segments 42, 43, 46, 47, 48, 49, and 50 have a less than 0.5-3% chance of contact from a summer spill originating at LA12 for 30 days and 1-4% chance of contact for 360 days.

Starting at LA10, winter contact percentages for the same environmental resource areas mentioned for the summer spill for a 30-day period are less than 0.5%, range from less than 0.5-1% over a 360-day period.

The same land segments listed for the summer spill have a less than 0.5% chance of contact within 30 days, and a less than 0.5-1% chance of contact within 360 days. Starting at LA12, for a 30-day period, contact percentages for the same environmental resource areas are less than 0.5%, and less than 0.5-2% over a 360-day period. The same land segments have a less than 0.5% chance of contact within 30 days, and a less than 0.5-2% chance of contact within 360 days.

Because bowheads migrate through the Beaufort Sea during June, biological effects on bowhead whales from the exposure to massive amounts of spilled oil could result in lethal effects to a few individuals, with the population recovering in 1-3 years. By this time, spilled oil will have weathered and would appear in the form of tarballs that are widely dispersed on the sea surface. It is possible, although not very likely, that Barrow, Nuiqsut, and Kaktovik would not be allowed to harvest bowhead whales as the migration moved east through the Beaufort Sea the following fall. It also is possible that while the bowhead whale harvest might not be curtailed, the quota could be reduced for possibly 2 years, resulting in significant effects on the bowhead whale harvests of these three communities, making the bowhead less available for use or undesirable for an extended period.

Lethal biological effects on seals, polar bears, and fishes would result from a very large oil spill. Population changes in abundance and/or distribution of many of these species would require up to one or two generations for recovery to their former status. Bearded seal harvests at Barrow, Nuiqsut, and Kaktovik are not likely to occur at all for the season in which the spill occurred. In following years, harvests would be expected to occur in greatly reduced numbers. Marine and coastal bird harvests by Barrow, Nuiqsut, and Kaktovik could be reduced. Barrow, Nuiqsut, and Kaktovik fish harvests, particularly in river delta areas and along the coast, would be expected to be available but in reduced numbers for 1 year. It also is likely that for all subsistence resources, there could be reluctance to harvest any marine resources because of perceived tainting from oil. Tainting could affect a wider area than the actual area of contact, because seals and whales move among resource areas; an animal oiled in one location potentially could be harvested in another area, even though the harvest location had never been oiled.

IV.I.2.k(2) Effects of Cleanup Activities on Subsistence Resources and Harvests

Disturbance to bowhead whales, seals, polar bears, caribou, fish, and birds potentially could increase from oil-spill-cleanup activities. Offshore, skimmers, workboats, barges, aircraft overflights, and in situ burning during cleanup could cause whales to temporarily alter their swimming direction. Such displacement could cause some animals, including seals in ice-covered or broken-ice conditions, to avoid areas where they are normally harvested or to become more wary and difficult to harvest. Nearshore, workers and boats, and onshore, workers, support vehicles, heavy equipment, and the intentional hazing and capture of animals could disturb coastal resource habitat, displace subsistence species, alter or reduce subsistence hunter access to these species, and alter or extend the normal subsistence hunt.

The MMS requires the operator to provide an oil-spill-contingency plan that includes scenarios for cleaning up oil in open water, solid ice, and broken ice. These scenarios identify logistics, equipment, and tactics for the various cleanup responses. Spill cleanup would reduce the amount of spilled oil in the environment and would tend to mitigate spill effects. In the case of a winter spill, when few important subsistence resources are present, cleanup is likely to be fairly effective in dealing with a spill before migrating whales and other species return to the area during breakup and the open-water season. The response plan would include specific provisions for the communication of information about spill responses to local communities, and would include, as well, the input of community considerations through an Incident Management System. The inclusion of information on community considerations would be described in the Situation Status Summary. Overall, oil-spill-cleanup activities, far from providing mitigation, more likely should be viewed as adding additional impacts to subsistence harvests, potentially causing displacement of subsistence resources and subsistence hunters (see Impact Assessment, Inc., 1998).

Conclusion for Subsistence Resources and Harvest Patterns. Overall effects from a very large oil spill on subsistence-harvest patterns in the areas around the communities of Barrow, Nuiqsut, and Kaktovik would be significant because one or more important subsistence resources could become unavailable. This would result from their displacement; undesirability for use from contamination or perceived tainting;

reduced numbers or their pursuit becoming more difficult because of increased hunter effort; and increased risk or cost for a period of 1-2 years.

Biological effects to subsistence resources might not affect species distributions or populations, but disturbance could extend the subsistence hunt in terms of miles to be covered, making more frequent and longer trips necessary to harvest enough resources in a harvest season. The loss of waterfowl populations to oil spills would cause harvest disruptions that would be significant to subsistence hunters who regard the spring waterfowl hunt to be of primary importance. In the event of a large spill contacting and extensively oiling habitats, the presence of hundreds of humans, boats, and aircraft would increase the displacement of subsistence species and alter or reduce access to subsistence species by subsistence hunters.

IV.I.2.I. Sociocultural Systems

IV.I.2.I(1) Details on How an Oil Spill from a Blowout Might Affect Sociocultural Systems

A very large oil spill would affect sociocultural systems in a number of ways. First, overall effects on subsistence-harvest patterns could be significant, because one or more important subsistence resources could become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1-2 years. Any perceived disruption of the bowhead whale harvest from oil spills or from actual or perceived tainting of the meat anywhere during the bowhead inmigration, summer feeding, and outmigration could disrupt the bowhead hunt for an entire season, even though whales would not be rendered unavailable. In the event of a large spill contacting and extensively oiling habitats, the presence of hundreds of humans, boats, and aircraft present for oil-spill cleanup activities would increase the displacement of subsistence species and alter or reduce access to subsistence species by subsistence hunters. High effects levels on subsistence-harvest patterns could cause disruptions that could lead to a breakdown of kinship networks and sharing patterns and increased social stress in the community. Participating in the oil-spill cleanup, as local residents did in the *Exxon Valdez* oil spill in 1989, could cause residents to (1) not participate in subsistence activities, (2) have a surplus of cash to spend on material goods as well as drugs and alcohol, and (3) not seek or continue employment in other jobs in the community (as oil-spill-cleanup wages are higher than average). Indications are that the sudden, dramatic increase in income earned from working on cleaning up the *Exxon Valdez* spill and being unable to pursue subsistence harvests because of the spill caused a tremendous amount of social upheaval. This was particularly revealed with increases in depression, violence, and substance abuse (Picou et al., 1992; Cohen, 1993; Picou and Gill, 1993; Fall, 1992; Impact Assessment, Inc., 1990c; Fall and Utermohle, 1995; Human Relations Area Files, Inc., 1994).

A disruption of the kinship networks (i.e., social organization) could lead to a decreased emphasis on the importance of the family, cooperation, and sharing. Multiyear disruptions of subsistence-harvest patterns, especially to the bowhead whale, an important species to the Inupiat culture, could disrupt sharing networks, subsistence-task groups, and crew structures and could cause disruptions of the central Inupiat cultural value: subsistence as a way of life. These disruptions also could cause a breakdown in sharing patterns, family ties, and the community's sense of well-being and could damage sharing linkages with other communities. Other effects might be a decreasing emphasis on subsistence as a livelihood, with an increased emphasis on wage employment, individualism, and entrepreneurism. Effects on the sociocultural system, such as increased drug and alcohol abuse, breakdown in family ties, and a weakening of social well-being, could lead to additional stresses on the health and social services available. Effects on the sociocultural systems described above would be for 1-2 years, with a tendency for additional stress on the sociocultural systems but without tendencies toward displacement of existing institutions.

IV.I.2.I(2) Effects of Cleanup Activities on Sociocultural Systems

If a large oil spill occurred, employment for oil-spill response and cleanup could disrupt subsistence-harvest activities for at least 1-2 harvest seasons and disrupt some institutions and sociocultural systems. Most likely, it would not displace institutions. If a large spill contacted and extensively oiled coastal habitats, the presence of hundreds of humans, boats, and aircraft would displace subsistence species and alter or reduce access to these species by subsistence hunters. Cleanup of a 180,000-barrel spill could generate approximately 3,000 jobs for 1-2 years, declining to zero by the third year following a spill (see Section IV.C.10 - Economy). This dramatic employment increase could have sudden and significant effects, including inflation and displacement of Native residents from their normal subsistence-harvest activities by employing them as spill workers. Cleanup is unlikely to add population to the communities because administrators and workers would live in separate enclaves, but cleanup employment of local Inupiat could alter normal subsistence practices and put stresses on local village infrastructures by drawing local workers away from village service jobs.

Far from providing mitigation, oil-spill-cleanup activities more likely should be viewed as an additional impact, causing displacement of subsistence resources and subsistence hunters and employment disruptions (see Impact Assessment, Inc., 1998).

Conclusion for Sociocultural Systems. The effects of a very large oil spill on sociocultural systems would cause chronic disruption to sociocultural systems for a period of 1-2 years, with a tendency for additional stress on the sociocultural systems but without a tendency toward the displacement of existing institutions.

IV.I.2.m. Archaeological Resources

Offshore archaeological resources would likely not be disturbed by an offshore oil spill or from cleanup activities associated with an offshore oil spill. Following the *Exxon Valdez* spill, the greatest effects came from vandalism because more people knew about the locations of the resources and were present at the sites. Known and previously undiscovered archaeological sites would be vulnerable to vandalism. This type of damage increases with added population and activities during cleanup. Some workers directly disturbed archaeological sites during cleanup. However, effects from the *Exxon Valdez* cleanup were slight because the work plan and techniques changed as needed to protect archaeological and cultural resources (Bittner, 1993). To help protect archaeological sites during oil-spill cleanup, we can use various mitigating measures including avoidance (preferred), consulting on and inspecting the site, onsite monitoring, site mapping, scientifically collecting artifacts, and promoting awareness of cultural resources (Haggarty et al., 1991).

Two studies of the numbers of archaeological sites damaged by the *Exxon Valdez* spill had similar findings. In the first study by Mobley et al. (1990), of 1,000 archaeological sites in the area affected by the *Exxon Valdez* oil spill, about 24 sites (less than 3%) were damaged. In the second study by Wooley and Haggarty (1993), of 609 sites studied, 14 sites (or 2-3%) suffered major effects.

The significance of an archaeological site is more important than numbers of sites disturbed. Disturbing 20 archaeological sites that contain no significant or unique information may not be as harmful as disturbing one very significant site. However, after the *Exxon Valdez* spill, the Advisory Council on Historic Preservation declared all archaeological sites were to be treated as if they were significant and eligible for the *National Register of Historic Places.*

Conclusion. The greatest effects to onshore archaeological sites would be from cleanup activities resulting from accidental oil spills. The most important understanding from past cleanups of large oil spills is that the spilled oil usually did not directly affect archaeological resources (Bittner, 1993). The State University of New York at Binghamton evaluated the extent of petrochemical contamination of archaeological sites as a result of the *Exxon Valdez* oil spill (Dekin, 1993). Researchers concluded that the three main types of damage to archaeological deposits were oiling, vandalism, and erosion, but fewer than 3% of the resources would suffer significant effects. Offshore archaeological resources would most likely not be affected by an oil spill.

IV.I.2.n. Land Use and Coastal Management Programs

The policies that were relevant for Section IV.C remain relevant for this analysis. A spill of this magnitude (greater than or equal to 150,000 barrels of oil) is very unlikely. Policies related to oil spills (NSB CMP

2.4.4 (f) and (g) state that all plans must include requirements for a relief well, identification of support equipment, and specify the estimated time required to commence drilling and completing a relief well. An emergency countermeasure plan must identify steps that will be taken to protect human life and minimize environmental damage in the event of loss of drilling rig, ice override, or loss or disablement of support craft or other transportation systems. The policy also states that all offshore drilling operations and offshore petroleum storage and transportation facilities are required to have an oil-spill control and cleanup plan that must address specifics stated in the policy.

The MMS operating regulations at 30 CFR 250 Subpart B - Exploration and Development and Production Plans and 30 CFR 254 - Oil-Spill Response Requirements for Facilities Located Seaward of the Coastline address these issues and enforcement of these regulations should assure that there is not conflict with these oil-spill policies.

The very unlikely event of a spill of this size and the resulting cleanup activities would have significant effects on one or more subsistence resources and access to those resources. The NSB CMP policies discussed in Section 1V C.14.b(6) relate to impacts that "are likely and cannot be avoided or mitigated" and "development that will likely result in significantly decreased productivity of subsistence resources of their ecosystems." An oil spill of this size would be accidental and the probability of such an event is very low. Therefore, this is not considered to be a "likely" event that would introduce conflict.

The NSB CMP Best Effort Policy 2.4.5.1(b) states that Access (to subsistence resources) can be restricted when there is no feasible and prudent alternative. This policy may come into play as a result of oil-spill cleanup activity. If it is determined that there are no feasible and prudent alternatives, there would be no conflict with this policy.

Conclusion. Based on the low-probability of a very unlikely event such as this, and on compliance with existing MMS regulations for spill prevention and response, no conflicts are anticipated. For NEPA purposes such an event and its potential impacts must be analyzed, even though it is recognized to be very unlikely. This conclusion recognizes the very unlikely and accidental nature of such an event.

IV.I.2.o. Air Quality

Accidental emissions resulting from an unlikely very large oil spill could affect onshore air quality, but the effects would be low. Typical emissions from outer continental shelf accidents consist of hydrocarbons (volatile organic compounds); only fires associated with blowouts or oil spills produce other pollutants, such as nitrogen oxides, carbon monoxide, sulfur dioxide, and particulate matter. Please see Section IV.C.15.a(2) for a discussion of how an oil spill and oil-spill cleanup activities might affect air quality. Section IX.B.3.m of the Liberty final EIS (USDOI, MMS, Alaska OCS Region, 2002a) also contains a more detailed discussion of how a large oil spill might affect air quality; we incorporate that section here by reference. That section discusses evaporation of spilled oil, in situ burning, and the pollutants released by the evaporation and burning. The conclusion drawn there is that the concentrations of criteria pollutants would remain well within Federal air quality standards. Although that section discusses the effects of a very large spill from a tanker, the effects on air quality of a spill from any cause would be essentially the same.

The cleanup of a very large oil spill would require the operation of some equipment, such as boats and vehicles. Emissions from their operation would include nitrogen oxides, carbon monoxide, and sulfur dioxide. If some spilled oil should be burned (in situ burning) as part of a cleanup effort, that burning would release pollutants. Please see the reference from the previous paragraph for more details.

Conclusion. An unlikely very large oil spill could cause an increase in the concentrations of gaseous hydrocarbons (volatile organic compounds) which could affect onshore air quality, but any effects would be temporary. Concentrations of criteria pollutants would likely remain will within Federal air-quality standards. Therefore, the effects would be low.

IV.I.2.p. Environmental Justice

As part of the effort to look at all possible ways to minimize the likelihood of an oil spill, industry, MMS, and the Interagency Working Group have undertaken extensive studies of alternative production pipeline designs to address pipeline safety and oil-spill concerns. Extra-thick-walled pipelines, pipeline burial depths more than twice the maximum 100-year ice-gouging event, and an advanced leak-detection system (LEOS) have been explored to address the prevention of oil spills.

New mitigation being considered by MMS is a seasonal drilling restriction. This measure would provide protection to the bowhead whale and other subsistence resources by eliminating the potential for a blowout during periods of broken ice during the development phase of a project. This measure would be similar to the one required by the State of Alaska for the Northstar Project, which prohibits BPXA from drilling the first development well into targeted hydrocarbon formations during the defined broken-ice periods for the site location; drilling subsequent development wells into previously untested hydrocarbon formations during defined broken-ice periods; and is subject to the imposition of additional restrictions on a case-by-case basis. Adopting this mitigating measure for Sales 186, 195, and 202 would reduce the very low chance of a large blowout type oil spill during the development of the prospect and further reduce the already low chance of a large oil spill.

In terms of oil-spill-response initiatives, the MMS and the North Slope Borough are participants in the North Slope Spill Response Project Team that was established to provide area-wide spill response planning for local communities on the North Slope. The MMS Field Operations has an ongoing outreach effort to provide the North Slope Borough, the Alaska Eskimo Whaling Commission, the Inupiat Community of the Arctic Slope, and local Native villages information on oil-spill planning, response, and cleanup and ongoing spill-response research initiatives. MMS has invited local communities and tribal groups to regularly scheduled industry oil-response drills at Prudhoe Bay. Additionally, MMS held an Alaska Arctic Pipelines Workshop on November 8-9, 1999, in Anchorage to facilitate the exchange of technical information and current research on pipelines in the Arctic between the public, regulators, pipeline designers, and operators. The workshop consisted of presentations and breakout sessions on pipeline design, construction, operations, and maintenance. About 150 people, including North Slope Borough representatives, participated in the workshop.

The MMS supports initiatives to train village oil-spill-response teams as a way of guaranteeing local participation in spill response and cleanup; this effort provides a form of control and allows local Native communities to utilize their Traditional Knowledge about sea ice and the environment in the response process. Within the constraints of Federal, State, and local law, operators and Alaska Clean Seas would be encouraged, through a voluntary affirmative action program, to hire and train residents of the North Slope Borough and the Cities of Barrow, Nuiqsut, and Kaktovik in oil-spill response and cleanup.

The MMS Also is working with the oil industry to develop a comprehensive plan for dealing with subsistence claims, should an oil spill occur. The plan would include what constitutes proof of previous subsistence activities, what information is needed to support a claim, and how subsistence losses would be calculated for restitution. The object would be to develop a subsistence claim process manual that sets out the protocol for a subsistence hunter to follow in filing a claim. At the present time, the U.S. Coast Guard, at the urging of MMS, has started to rework their claim process to be more responsive to Native subsistence practices in Alaska. The MMS requires all operators to provide financial responsibility through bonds as required by the Oil Pollution Act of 1990.

Other suggested mitigation initiatives for impacts on subsistence species from oil spills include potential staging of equipment such as ice-hardened barges and/or an icebreaking vessel at critical locations to support any necessary oil-spill cleanup operations. This initiative would address response-readiness concerns of subsistence users. Also, the staging of boom material and other pertinent response equipment at Barrow, Cross Island, and Kaktovik would provide protection to critical whaling areas and shoreline. These measures could be included in the oil-spill-contingency plan or in the final Condition of Permit approval letter for a production project issued by the Regional Supervisor for Field Operations.

The oil-spill-contingency plan also could include tactics for protecting bowhead whales. Hazing could be used to divert bowhead whales away from a spill, if they happened to be in the area at the time of an oil spill. The MMS acknowledges that present mechanical cleanup technology has not demonstrated cleanup ability in broken-ice conditions. In situ burning is a nonmechanical response method available for spill response and could be quite effective in ice conditions where mechanical cleanup techniques have been rendered problematic. Collectively, these stipulations and other proposed mitigation would aid substantively in mitigating against contamination to onshore habitats and subsistence resources.

Conclusion. Alaska Inupiat Natives, a recognized minority, are the predominant residents of the North Slope Borough, the area potentially most affected by a very large oil spill. Effects on Inupiat Natives could occur because of their reliance on subsistence foods, and cumulative effects may affect subsistence resources and harvest practices. Oil-spill contamination of subsistence foods is the main concern regarding potential effects on Native health. The MMS believes that serious mitigation for such impacts begins with a commitment to preventing spills in the first place, by employing the highest standards of exploration, development and production technology.

Potential effects would focus on the Inupiat communities of Barrow, Nuiqsut, and Kaktovik within the North Slope Borough. If a very large spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Such impacts would be considered disproportionately high adverse effects on Alaskan Natives. Any potential effects to subsistence resources and subsistence harvests from a large oil spill are expected to be mitigated to some extent, though not eliminated.

SECTION V

CUMULATIVE
EFFECTS

Contents of Section V

V. Cumulative Effects

V.A. INTRODUCTION AND GENERAL CONCLUSIONS

V.A.1. Introduction

To help determine the structure and scope of our cumulative-effects analysis, we were guided by our experience in preparing cumulative effects analyses and by the National Environmental Policy Act (40 CFR 1508.7) and 1508.25(a)(2):

> "Cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.
>
> To determine the scope of environmental impact statements, agencies shall consider…Cumulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement.

A handbook issued by the Council on Environmental Quality, *Considering Cumulative Effects Under the National Environmental Policy Act, January 1997*, suggests, among other things, that the analyses "determine the magnitude and significance of the environmental consequences of the proposed action in the context of the cumulative effects of other past, present, and future actions…identify significant cumulative effects…" and "…focus on truly meaningful effects." As suggested by this handbook, we consider the following basic types of effects that might occur:

- "additive" (the total loss of animals from more than one incident),
- "countervailing" (adverse effects that are compensated for by beneficial effects), and
- "synergistic" (when the total effect is greater than the sum of the effects taken independently).

The publication *Guidelines for Environmental Impact Assessment in the Arctic* (Finnish Ministry of the Environment, 1997) indicates that a "cumulative impact assessment should be kept at reasonable and manageable levels" and, thus, need not be voluminous and exhaustive.

V.A.2. Structure of the Analysis

Based on a consideration of our experience and these references, we designed our cumulative-effects analysis for this EIS as a 5-step process:

1. We identify the potential effects of the Beaufort Sea multiple sale on the natural resources and human environment that may occur in the Beaufort Sea, on the North Slope, and along the oil-transportation route.
2. We analyze other past, present, and reasonably foreseeable future oil-development activity on the North Slope/Beaufort Sea for effects on the natural resources and human environment that we found were potentially affected by the Beaufort Sea multiple sales.
3. We consider effects from other actions (sport harvest, commercial fishing, subsistence hunting, and loss of overwintering range, etc.) on these same natural resources and human environments.
4. We attempt to quantify effects by estimating the extent of the effects (number of animals and habitat affected) and how long the effects would last (population recovery time).
5. To keep the cumulative-effects analysis useful, manageable, and concentrated on the effects that are meaningful, we weigh more heavily other activities that are more certain and geographically in the Near Zone, and we analyze more intensively those effects that are of greatest concern. We also focus our effort by using, where possible, guiding principles from existing standards (see the following), criteria, and policies that control management of the natural resources of concern. Where existing standards, criteria, and policies are not available, our experts use their best judgment on where and how to focus the analysis.

V.A.3. Guiding Principles of the Analysis

The Endangered Species Act of 1973 and the Beaufort Sea multiple-sale scoping process are appropriate vehicles to identify species that are potentially at risk from incremental cumulative effects from the Beaufort Sea multiple sales. Effects on listed species identified for the Beaufort Sea multiple sales by the National Marine Fisheries Service and the Fish and Wildlife Service under Section 7 of the Endangered Species Act are covered by this cumulative-effects analysis. We also review the effects on each of the other species identified through scoping and include them, as appropriate.

We assess cumulative effects on those species listed as “endangered,” “threatened,” “proposed,” or “candidate” on the North Slope, in the Beaufort Sea, and along the transportation corridor to West Coast ports that the National Marine Fisheries Service and the Fish and Wildlife Service indicate that we should assess. We assess endangered and threatened species in more detail than proposed or candidate species. We assess other cumulative effects on natural resources and the human environment in these same areas but in less detail than listed species, unless we find that they are likely to be “significant cumulative effects” under Council on Environmental Quality guidelines. We also include effects along migration routes of species, as appropriate.

The management of seals by the National Marine Fisheries Service and polar bears by the Fish and Wildlife Service under the Marine Mammal Protection Act of 1972 provides for monitoring these species’ populations and managing/mitigating potential effects of development on these species. For example, the Fish and Wildlife Service implements measures to protect polar bear den sites through a Letter of Authorization under the Marine Mammal Protection Act.

The State of Alaska, Department of Fish and Game, monitors caribou, including the Central Arctic Herd, by a census of caribou calving and caribou distribution on the oil fields. These monitoring efforts provide a means of indicating if significant cumulative effects on caribou have occurred or are occurring on the North Slope and help to develop measures to minimize effects.

We assess cumulative effects to all other species over the range that the species may be affected by activities associated with Beaufort Sea Sales 186, 195, and 202 and also include effects along the migration routes of some species, as appropriate.

Water quality on the North Slope is regulated and/or monitored through various permitting and regulatory programs administered by the Environmental Protection Agency; the Alaska Departments of Natural Resources, Environmental Conservation, and Fish and Game; and the North Slope Borough. These programs have been established to protect against the significant degradation of water quality associated with specific human/development activities. In evaluating the cumulative effects to water quality, we consider the collective impacts associated with permitted/regulated activities in addition to other nonregulated activities and/or naturally occurring events.

Air quality is regulated under the Prevention of Significant Deterioration permitting process. For sources located in the OCS (such as the proposed Beaufort Sea multiple sales), the Prevention of Significant Deterioration program is administered by the Environmental Protection Agency. For sources located in State waters and onshore, the Prevention of Significant Deterioration program is administered by the Alaska Department of Environmental Conservation. Minor sources of air pollutants are not subject to Prevention of Significant Deterioration permitting requirements. The analysis of cumulative effects to air quality in this EIS considers the contribution of major and minor sources of air pollution on the North Slope.

Wetlands are mitigated through the Section 404 Regulatory Program under Section 404 of the Clean Water Act, administered by the U.S. Army Corps of Engineers. In addition, the Administration has a No-Net-Loss goal for wetland functions and values, as stated in the White House Office on Environmental Policy entitled *Protecting America's Wetlands: A Fair, Flexible, and Effective Approach,* dated August 24, 1993. The *Memorandum Of Agreement Between The EPA And The U.S. Army Corps of Engineers Concerning The Determination Of Mitigation Under The Clean Water Action Section 404(B)(1) Guidelines* provides a sequence for mitigation that includes avoiding and minimizing of and compensating for wetland losses. Under the Memorandum of Agreement, it is recognized that in areas such as the North Slope of Alaska (where there is a high proportion of wetlands), minimizing wetland losses will be the primary method of mitigation. However, compensatory mitigation could be required for unavoidable losses to high-use wetlands. Minimizing wetland losses also includes selective use of surrounding wetlands over high-use wetlands, for example, minimizing the impact from the placement of fill material into waters of the U.S. Therefore, potential cumulative impacts to wetland resources are tempered through Federal, State, and local regulatory programs. Including appropriate best management practices and environmental conservation conditions to oil and gas leases and exploratory, development, and production phases substantially lowers the likelihood of collective development actions that result in potential significant impacts to wetlands. We analyze the potential impacts resulting from the placement of fill material and the potential impacts resulting from oil-spill scenarios.

For the human environment (subsistence activities, sociocultural systems, and the economy), we focus our evaluation of cumulative effects associated with oil-development activities on the North Slope local environment, because this is where most significant cumulative effects are expected to be concentrated. We consider effects along the bowhead migration route in the Beaufort and Chukchi seas, because these villages share a subsistence resources base and their survival is based on the abundance of game and hunting success. However, we also give some consideration to effects on the human environment along the transportation route.

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, and an accompanying Presidential memorandum, require each Federal Agency to make the consideration of environmental justice part of its mission. The existing demographics (race, income) and subsistence consumption of fish and game are discussed, disproportionate environmental and health effects on Alaskan Natives are identified, and mitigating measures and their effects are presented.

Executive Order 13084, *Consultation and Coordination with Indian Tribal Governments*, requires the MMS to consult with Inupiat tribal governments on the North Slope on "Federal matters that significantly or uniquely affect their communities," so that an effective process is established that "permits elected officials and other representatives of Indian tribal governments to provide meaningful and timely input." We have met with local tribal governments to discuss subsistence issues relating to the Beaufort Sea multiple sales and have established a dialogue on environmental justice with these communities. Mitigation in place for the Beaufort Sea multiple sales (measures developed for Beaufort Sea Sale 144) evolved through negotiations with local, Borough, and agency representatives, and Inupiat Traditional

Knowledge had a large part in developing mitigation and in the timing of project activities. Conflict avoidance agreements between the oil industry and Inupiat whalers are an important mechanism for overcoming conflicts.

The cumulative effects on archaeological resources can be minimized through required surveys, consultations with the State Historical Preservation Officer to identify potential archaeological sites, and requirements to plan and schedule activities to avoid these locations. We analyze the potential for disturbances of archaeological resources on the North Slope and in the Beaufort Sea in addition to the potential effects from cleanup of oil spills along the transportation route.

V.A.4. Scope of the Analysis

Oil and gas activities occur on the outer continental shelf in Alaska, the Gulf of Mexico, and California and are cited in the most recent 5-year EIS. In this EIS we evaluate the cumulative effects of transporting Alaskan oil along the U.S. West Coast. To be consistent with the 5-Year OCS Oil and Gas Program, the Beaufort Sea multiple sale cumulative analysis also evaluates the effects for transporting oil through the Trans-Alaska Pipeline System and tankering from Valdez to U.S. West Coast ports. Activities other than those associated with oil and gas also are considered. We also include by reference certain cumulative effects that are more national in scope, for example, global warming and alternative energy development.

Oil and gas activities considered in the analysis include past development and production, present development, reasonably foreseeable future development, and speculative development. Some activities beyond the 15- to 20-year life of the Beaufort Sea multiple sales are considered too speculative at this time to include, while other such activities are included in this analysis. Furthermore, we exclude future actions from the cumulative-effects analysis, if those actions are outside the geographic boundaries or timeframes established for the cumulative-effects analysis. We address uncertainty through monitoring, and note that monitoring is the last step in determining the cumulative effects that ultimately might result from an action.

V.A.5. "Significance"

As directed by the Council on Environmental Quality National Environmental Policy Act regulations (40 CFR 1502.16), we discuss direct and indirect impacts (effects) and their significance on physical, biological, and human social resources. The specific resource topics considered (for example, endangered species or water quality) are those listed here in the introductory paragraph. Our analysis considers the "context" and "intensity" of the impact as mentioned by the Council on Environmental Quality in characterizing "significantly" (40 CFR 1508.27). The context aspect considers the setting of the proposed action, what the affected resource may be, and whether the effect on this resource is local or more regional in extent. The intensity aspect considers the severity of the impact taking into account such factors as whether the impact is beneficial or adverse; the uniqueness of the resource (for example, threatened or endangered species); the cumulative aspects of the impact; and whether Federal, State, or local laws may be violated. When considering cumulative effects, the geographic area and timeframe are extended to include past, present, and reasonably foreseeable activities. Overlapping zones of influence and the incremental contribution of the proposed activity also are evaluated in the cumulative case.

V.A.6. General Conclusions

The MMS would agree with a recent synthesis of oil-field development in the Arctic that includes the nearshore anadromous fish habitat and marine invertebrate Boulder Patch kelp community. This historical assessment to the present concluded that the oil-field ecosystem continues to function much as it did prior to development, constrained primarily by the forces of climate, landscape structure, and nutrient availability and cycling. Development actions locally have changed the distribution and abundance of some food-web and vertebrate components of the ecosystem. Whether the sizes and levels of productivity of regional vertebrate populations have been affected by development remains largely unknown; any potential evidence of such effects have been obscured by the much greater changes caused by natural phenomena (Truett, 2000).

Conclusions about effects on specific resources follow later in this section. Our general conclusions of this cumulative analysis that if the resources that, for analytical purposes, we assumed would be developed are indeed developed:

- Potential cumulative effects on the bowhead whale, subsistence, sociocultural systems, spectacled eider, boulder patch, polar bear, and caribou would be of primary concern and warrant continued close attention and effective mitigation practices.
- The incremental contribution of Sale 186 to the cumulative effects likely would be quite small. Construction and operations related to the Beaufort Sea multiple sales primarily would be concentrated in the Near Zone, and oil output would be a small percentage (approximately 7%) of the total estimated North Slope/Beaufort Sea production.
- Sale 186 would contribute a small percentage of offshore oil spills (about 18%) [0.11 spills out of 0.65 total; the most likely number of spills is zero] to resources in State and Federal waters in the Beaufort Sea. Any subsequent spills are not expected to contact the same resources or to occur before those resources recover from the first spill.
- Potential environmental justice effects would focus on the Inupiat communities of Barrow, Nuiqsut, and Kaktovik within the North Slope Borough. In the unlikely event a large spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Such impacts would be considered disproportionately high adverse effects on Alaskan Natives.

V.A.7. Other Information about Cumulative Effects

We recognize the importance of readily available abiotic standards to determine environmental quality. Abiotic measurements (for example, air and water quality) often provide a good indication of the quality of biological and cultural resources. We also recognize that as we move from the abiotic to the biotic to the human condition, the variables increase, making it more difficult to determine cumulative effects on the quality of life. Similarly, as we move from the terrestrial environment to the offshore environment, the variables of environmental quality increase. Migratory species present additional variables that reflect habitat and species condition outside the primary study areas. Humans introduce even more variables with their mobility and behavioral diversity. Hence, as we progress from abiotic to biotic, or from freshwater to marine, or from terrestrial and marine to sociocultural effects, our analysis, by necessity, becomes more difficult and less conclusive (Figure V-1).

We assessed cumulative effects in this EIS to determine whether these effects were additive or synergistic or had some other relationship. Additive or combined effects on specific resources often are difficult to detect and do not necessarily add up in the numeric sense of 1 plus 1 equals 2. It is much more likely that an additive or combined effect would be greater than 1 but less than 2. A synergistic effect, in theory, is a total effect that is greater than the sum of the additive effects on a resource. To arrive at a synergistic effect in this example, we would need to detect a total cumulative effect greater than 2. In the highly variable arctic environment, where natural variations in population levels can exceed the impacts of human activity, such an effect would need to be much greater than 2 to be measurable or noteworthy.

While synergistic impacts have been demonstrated in the laboratory (for certain types of chemical reactions, for example), there is almost no evidence of such impacts occurring when dealing with biological resources in the arctic environment. We recognize that synergistic impacts could occur, but we found none for the Beaufort Sea multiple sales, the EIS alternatives, or in our assessment of cumulative effects. In effects sections, where synergistic impacts were not specifically enumerated, it was because there were neither studies nor information that led us to specifically identify such impacts.

Concern about the potential for cumulative effects should be weighed with the following information:

- Estimated oil and gas activities likely would have fewer impacts on the environment than those activities conducted in the early years of the region's development. More rigorous environmental standards and more environmentally prudent industry practices now exist, which include smaller facility "footprints," fewer roads, directional drilling from onshore, elimination of most discharges into the water, practices that avoid damage to the tundra, and better working relations with the local residents.
- Current industry practices and the environmental state of the North Slope/Beaufort Sea region frequently are observed and assessed, and much of this information is available to the public. This information and the ongoing dialogue about environmental issues among Federal, State, and local government agencies; Inupiat regional and village corporations; industry; interest groups; and the public should continue to increase environmental awareness and encourage environmentally sound practices that, in turn, should help reduce the potential for environmental damage.
- A key element of the transportation system for development of North Slope/Beaufort Sea oil is the Trans-Alaska Pipeline System pipeline. The pipeline is 800 miles long, stretching from Pump Station 1 at Prudhoe Bay to the Valdez Marine Terminal and, if we choose a corridor width of about 100 feet, it represents an area of about 16 square miles. This pipeline is expected to continue to serve as existing infrastructure for all foreseeable future oil production, eliminating the need for the construction of new oil pipelines other than feeder pipelines.
- Following the *Exxon Valdez* oil spill, substantive improvements have been made in tanker safety to reduce the potential for oil spills from tanker accidents. These include a mandatory phase-in of double-hulled tankers, better navigational systems, and tanker escorts. In addition, oil-spill-response capabilities for tanker-related oil spills in Prince William Sound have been increased substantially through additional equipment, personnel, training, and exercises. These initiatives were developed specifically to reduce the potential for future tanker accidents and to lessen effects, should spills occur.
- If a major oil spill occurred, there likely would be a slowdown in new development during which additional safeguards certainly would be put in place and new ideas of pipeline placement and design would be researched. Just as the additional safeguards resulted from the *Exxon Valdez* oil spill, the likelihood of an additional oil spill from the same causative factors and to the same resources would be reduced. This emphasis on preventing a similar incident further would ensure the full recovery of those resources from the initial spill.
- The actual size and location of future oil and gas developments on the North Slope and in the Beaufort Sea are uncertain. The actual effects on natural resources and the human environment that may result from such developments also are uncertain. Nevertheless, we have developed our best estimate of what those activities and effects might be. However, it is likely that projected actions or effects may not happen in a way that fits neatly into the scenarios we have established for this EIS. Therefore, the MMS established a Beaufort Sea monitoring program focused on the Northstar Project and the Liberty Project area. Data have been gathered for 3 years. The program is establishing a baseline data. This program will provide feedback to decisionmakers who could amend mitigation provisions, if appropriate, at a later date.

In Section V.B, we describe the activities and projects we consider in this analysis. These activities include past development and production, present development, reasonably foreseeable future development, and speculative development. Some activities beyond 20 years are considered too speculative at this time. Activities other than oil and gas activities also are considered. In Section V.C, we present the assumptions used by each resource specialist in the remainder of the analysis in that section.

V.B. ACTIVITIES WE CONSIDERED IN THIS CUMULATIVE-EFFECTS ANALYSIS

Oil and gas development is the main agent of industrial-related change on the North Slope. Oil and gas exploration and production activities have occurred on the Alaska North Slope/Beaufort Sea region for more than 50 years. Past industrial development that occurred in association with this historic production included the creation of an industry support community and airfield at Deadhorse and 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 developed to transport North Slope crude oil to a year-round marine terminal in Valdez, Alaska, and it continues today and for the foreseeable future to transport the entire production from the North Slope. In November 2002, an EIS was written and the TAPS Right-of-Way was renewed for another 30 years by both State and Federal agencies.

For our analysis, we formulate oil and gas scenarios based on our estimate of future activities. Our scenarios are conceptual views of the future. Underlying the cumulative-effects assessment and the assessment of the Alternative I for Sale 186 and the other alternatives, we offer scenarios on the timing and extent of future petroleum activities in the Beaufort Sea and on the North Slope.

Estimates of anticipated production consider many factors, including the economically recoverable resources of the area, past industry leasing and exploration efforts, and future economic conditions. In the Beaufort Sea, only 7 of 23 scheduled Federal sales were held, and a small fraction (692) of the tracts offered for lease (10,280 tracts in the 7 sales) were leased. Few of the leases actually were tested by drilling (30 wells on 20 prospects). Most discoveries (11 wells determined to be producible) are too small or too costly to become viable fields (one field, Northstar, is producing; one, Liberty, recently suspended further development indefinitely). Under optimum conditions, the chance that commercial fields will be discovered could be 10-20%. However, on the North Slope, the success rate for finding new commercial fields is likely to be lower. Consequently, anticipated production volumes and associated environmental effects often turn out to be overstated. For example, we expected that if the Liberty Project was approved in spring 2002, production would start within a couple of years; however, in January 2002, BPXA chose to put the project on the shelf pending a review of costs. BPXA has indicated they likely will submit a modified development plan, but when and if that will actually occur is unknown.

We focus our analysis on the following:

- Oil and gas discoveries that have a reasonable chance of being developed during the next 15-20-years.
- Exploration and development of additional undiscovered resources (onshore and offshore) that could occur during the next 15-20-years.
- Some exploration and development activities that could occur after the 15-20-years from future State and Federal lease sales.
- Transportation of oil in the Trans-Alaska Pipeline System and tankering of oil to western ports.
- Activities other than oil and gas such as sport and subsistence hunting and fishing, commercial fishing, sport harvest, loss of overwintering range, tourism, and recreational activities.

Table V-1a lists North Slope fields and discoveries. Tables V-lb and V-1c list the current and proposed transportation projects and future lease-sale activities we consider in this cumulative analysis. Figure III.A-1 shows the location of fields and discoveries in Table V-1a and areas of exploration. “Fields” refers to a geologic structure with proven reserves that has been developed and is producing crude oil. Fields can contain numerous reservoir pools produced through a common infrastructure. “Discoveries” refers to a pool with potential reserves that has not been developed. Some discoveries require additional drilling to confirm that oil or gas is commercially recoverable. Poor test results in some “discoveries” may be referred to simply as shows. The development timing of resources listed as prospects or shows is speculative and could occur after more than 20 years.

For purposes of this cumulative analysis, we divide oil and gas discoveries into the following categories:

- **Past Development/Production:** 31 fields and satellites, with Endicott, Sag Delta, Sag Delta North, Point McIntyre, Niakuk, Eider, and Northstar located offshore.
- **Present Development/Production:** 3 discoveries that are expected to start up within the next few years, all of which are onshore.
- **Reasonably Foreseeable Future Development:** 16 discoveries that might see some development-related activities (site surveys, permitting, appraisal drilling, or construction) within the next 15-20 years, with Liberty, Kalubik, Gwydyr Bay, Sandpiper, Flaxman Island, Kuvlum, Thetis Island, Stinson, and Hammerhead located offshore. Additional onshore resources (estimated 2.30 billion barrels) and offshore resources (estimated 1.38 billion barrels) currently are undiscovered.

- **Speculative Development:** Additional new discoveries could be made and developed beyond 20 years, with 13 past onshore discoveries. The chance for development is too uncertain for detailed analysis at this time. Additional exploration activities (wells and seismic surveys) are likely to occur and have been factored into the analysis.

We focus on the first three categories and consider exploration activities of the fourth category. We recognize that oil companies may produce oil from pools in the speculative development category. However, there is no way to know this with any degree of certainty, because insufficient information exists to estimate the development activities associated with undiscovered pools. Some discoveries date back to 1946 without subsequent development. It is possible that oil companies also would not develop some prospects in the reasonably foreseeable category within the 15-20-year timeframe. We estimate a total resource amount for the speculative category from industry and government reports. Onshore and offshore undiscovered resource estimates are based on MMS's 1995 National Assessment minus discoveries included as possible outer continental shelf projects (Table V-7d).

V.B.1. Past Development/Production

This category includes producing fields on the North Slope and nearshore areas of the Beaufort Sea. Infrastructure, cumulative production, and remaining reserves are well defined. Individual oil pools can be developed together as fields that share common wells, production pads, and pipelines. Fields can be grouped into production units with common infrastructure, such as processing facilities. Impacts associated with development have occurred over the past three decades, and there are data from monitoring that accurately reflect some of the long-term effects.

This category contains 31 discoveries, all of which are now producing oil (see numbers 1 through 31 in Table V-1a). Table V-2 lists production and reserve data, and Table V-3 lists infrastructure and facilities for these producing fields. All these fields except Northstar, Endicott, Sag Delta North, and Eider are onshore on State leases. Endicott is an offshore State field that began production in 1987 and, through 1996, had produced 330 million barrels of oil. The Niakuk, Point McIntyre, and Badami oil fields are located mainly offshore but are produced from onshore sites. Badami is of particular interest, because the proposed Liberty Project pipeline and Point Thomson proposed pipeline would tie into Badami's common-carrier pipeline. Northstar began producing on October 31, 2001.

During 1996, ARCO announced that the Alpine Prospect locate in the Colville River Delta, was producible and contained an estimated 365 million barrels of oil. More recent estimates of Alpine are over 429 million barrels. It is the largest onshore discover in the United States in more than a decade. Alpine came on line in November 2000 and produces approximately 80,000 barrels of oil per day. Oil is transported via a 34-mile pipeline to the Kuparuk oil field facility. Ice roads and bridges support activities in the winter. There are no gravel roads connecting the Kuparuk infrastructure to Alpine.

The Meltwater discovery is estimated to contain about 50 million barrels of oil. The West Sak field began production in 1997 and Tarn and Tabasco fields began production in 1998. The Meltwater discovery about 10 miles south of Tarn, marks the further extension south for the Kuparuk infrastructure. Palm, an extension of the Kuparuk formation has about 35 million barrels of recoverable oil. BP recently began production at the Northstar Unit. They estimate that Northstar will produce 145 million barrels of oil over a 15-year period. BP has also started production at Aurora and Borealis, two of five Prudhoe Bay satellite fields.

V.B.2. Present Development/Production (Within the Next Few Years)

This category includes fields that are in planning stages for development but that have not begun production. Infrastructure components, scheduling, and reserve estimates are fairly well defined, although reserve volumes could be revised later. Commonly, new planned developments will be tied into existing infrastructure, and they depend on the continued operation of this infrastructure.

This category contains three discoveries: CD North (Fjord), CD South (Nanuk/Nanuq), and Orion (NW Eileen) (Table V-1a). Table V-4 lists reserve estimates, and Table V-5 lists the infrastructure the oil companies propose for these discoveries. All are onshore on State leases. Recent discoveries near the Alpine formation include CD South (Nunuq) is estimated to contain about 40 million barrels of oil. CD North (Fjord), also an Alpine satellite, is estimated to contain about 50 million barrels of oil.

V.B.3. Reasonably Foreseeable Future Development/Production (Within the Next 15-20 Years)

The MMS developed the information about reasonably foreseeable future development and production and considers it the best available information. This category includes activities that are reasonably foreseeable within the next 15-20 years. It is reasonable to expect that these activities would begin with the development of discoveries in close proximity to existing (past and present) fields to share infrastructure. We have attempted to rank the chance of development according to resource size and proximity to existing infrastructure. Resource volumes are uncertain in this category. There generally are inadequate drilling data to define reserves or engineering studies to support development. Also, we cannot predict the development timing for future fields. Many of these discoveries were made decades ago and remain noncommercial today. Without technology advancements and higher petroleum prices, many of these discoveries could remain undeveloped.

While the list of reasonably foreseeable future developments includes only discoveries, there could be significant amounts of oil produced by enhanced oil recovery from existing fields in addition to from undiscovered satellite pools close to infrastructure areas. Enhanced recovery adds additional production from known reservoirs, creating “reserve growth.” For example, the Prudhoe Bay field was originally estimated to hold 9.6 billion barrels of reserves, and now it has reserves approaching 13 billion barrels. More than 3 billion barrels were added by using enhanced recovery technologies. In addition, industry has indicated that they have a large number of prospects very close to existing infrastructure that may become future satellite pools. Although both of these new resources (reserve growth and satellites) are as yet undiscovered, it is reasonable to assume that a significant portion would be brought into production in the next 20 years or sooner. For purposes of analysis, we assume that half of the total (4 billion barrels) estimate for enhanced recovery and satellite fields (or 2 billion barrels) would be brought into production in the foreseeable future. Because satellite fields largely would be developed from existing infrastructure, the incremental addition of new infrastructure is minor.

This category includes 16 discoveries that oil companies may begin to develop in the next 15-20 years (see numbers 35 through 50 in Table V-1a). Table V-6a lists the resource estimates. Offshore discoveries in this category are Liberty, Sandpiper, Flaxman Island, Kuvlum, Hammerhead, Thetis Island, and Stinson. Gwydyr Bay and Kalubik are offshore discoveries that are likely to be developed from onshore sites. Onshore discoveries include Sourdough, Mikkelsen, Yukon Gold, Point Thomson, Pete’s Wicked, and Sikulik (near the existing Barrow gas fields). Sandpiper, Hammerhead, and Kuvlum are on offshore Federal leases; all others are on State leases or North Slope Borough lands. Spark/Rendezvous is a recent discovery in northeastern National Petroleum Reserve-Alaska. Appraisal-well drilling has taken place over two winter seasons since its discovery in 2000; however, reserve estimates and a timetable for development have not been announced by the operator (Phillips Alaska, Inc.). The discussion of reasonably foreseeable future development/production will include the effects of production decline from existing fields, the current proposals for new development, and estimates of potential development associated with recent and proposed lease sales.

Tables V-6a and V-6b indicate the possible development infrastructure, should these discoveries be commercially developed. Oil from the Kalubik and other small accumulations in the Colville Delta could feed into the Alpine pipeline system, should they be developed. Development of the Spark/Rendezvous discovery also could use the Alpine infrastructure. Oil produced from the Gwydyr Bay, Pete’s Wicked, and Sandpiper discoveries could be transported through the Northstar pipeline, while the Badami field trunk pipeline would provide transport for other discoveries in the eastern North Slope listed in Table V-6a. An indication of the infrastructure that may be required if these discoveries are developed is listed in Table V-6b. Outlined on Figure III.A-1 are the geographic boundaries of the Alpine, Northstar, and Badami fields and the discoveries these fields may service.

It is important to recognize the distinction between exploration/development activities and production. The discussion of exploration/development activities is related primarily to disturbance effects, whereas the estimated production volumes relate directly to oil-spill risk. We have attempted to rank the chance for commercial development of these discoveries from highest to lowest (Table V-1a). The ranking 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 after 20 years.

V.B.4. Speculative Development (After 20 Years)

This category includes small discoveries and undiscovered resources that are very unlikely to be developed in the timeframe of less than 20 years. Some of the discoveries listed in Table V-1a were made 50 years ago and remain noncommercial today. There are a variety of reasons, including very remote locations, low production rates, and lack of gas-transportation systems that will remain in effect in the foreseeable future. With respect to undiscovered resources, it is not reasonable to estimate new infrastructure or predict the effects of development for prospects that have not been located or leased to industry for exploration. Accurate predictions of the location, size, or development schedule are not possible at this time.

Various government and industry groups publish resource estimates that often vary widely for a given area. However, these groups use very different methodologies and reporting criteria. It is difficult to discern how these speculative undiscovered resource estimates would translate in future infrastructure and effects. The resources listed in Table V-7d fall beyond the definition of reasonably foreseeable.

With respect to the offshore resource estimates, the leasing history for the Beaufort Sea suggests that the majority of production is likely to occur before most offshore projects. Any new development or additional oil production is likely to occur in nearshore areas adjacent to existing infrastructure. Development of additional offshore resources in deeper waters of the Beaufort Sea will be largely dependent upon the more nearshore exploration and development success.

Speculative resources include both discovered (uneconomic) and undiscovered (speculative) resources that may be developed after more than 20 years (Tables V-7c and 7d). Future development depends on favorable economic conditions. This category also includes undiscovered oil resources expected to be developed as a result from future State and Federal lease sales (Table V-1c). Table V-7c lists speculative production from three sources: (1) enhanced recovery and satellite onshore accumulations near existing onshore infrastructure (50% of the 4.0-billion barrels total); (2) another 0.3 and 0.37 billion barrels and assumed to be discovered and developed in the northeast and northwest National Petroleum Reserve-Alaska; and (3) a portion of the undiscovered resource base for offshore. Because these resources are undiscovered, no specific location or potential field size can be provided. Although the individual resource volumes are not known, this category also includes 13 discoveries that may be developed after 20 years (see numbers 51 through 63 in Table V-1a). All these discoveries are located onshore.

Development of gas resources on the North Slope is included in the speculative category, because gas has been uneconomic to produce for several decades and may continue to be uneconomic in the future. The largest gas accumulation on the North Slope is in the Prudhoe Bay field (46 trillion cubic feet originally in-place, approximately 25 trillion cubic feet available now for sale). Various plans have been studied to bring North Slope gas to market, but no plan has overcome the high project cost and marketing hurdles. Because known gas resources are uneconomic today, it is difficult to predict the timing or scale of future gas production projects. According to general consensus, gas sales from Prudhoe Bay could start as early as 2010. However, ample supplies exist in the Prudhoe Bay field to supply a large-scale gas export project for at least 20 years. The surrounding oil fields also have available gas resources that could feed into the North Slope gas transportation system. It is very unlikely that development of remote, undiscovered, and higher cost gas resources would occur while there are adequate supplies of known, readily available reserves. The existing North Slope oil infrastructure is capable of handling large amounts of natural gas (38.7 trillion cubic feet have been cycled through its facilities through 1999).

These four development categories represent all known oil and gas sources that potentially could be developed on the North Slope and Beaufort Sea. The analysts preparing this EIS focus on the first three oil and gas development categories and consider the fourth category (speculative) with respect to seismic and associated exploration activities associated with future State and Federal lease sales. Other activities and issues could be analyzed as they apply to particular resource topics. These areas of additional evaluation may include cumulative effects from activities related to development in migratory overwintering ranges, environmental contamination, subsistence harvest, sport harvest, commercial fishing, marine shipping, tourism, and recreational activities.

V.B.5. Oil Production on the North Slope of Alaska

V.B.5.a. Production Through 2000

Since the first production well was drilled on the Prudhoe Bay structure, North Slope developments produced 13.306 billion barrels of oil by the end of 2000 (Table V-7a). Production on the North Slope peaked in 1988 at 2.0 million barrels of oil per day, declining to its current rate of 0.95 million barrels per day. Of the producing fields on the North Slope, the most productive, in order, are Prudhoe Bay, Kuparuk River, Point McIntyre, and Endicott. Figure III.A-1 shows producing fields and potential development areas within the North Slope.

V.B.5.b. Resource Estimates We Used for This Cumulative-Effects Analysis

Tables V-7b and V-7c show the reserve and resource estimates we use for analyzing cumulative effects. We estimate a low range of 6 billion barrels, a mid-range of 11 billion barrels, and a high range of 15 billion barrels of oil reserves and resources that may be produced on the onshore North Slope and in the Beaufort Sea.

V.B.5.b(1) The Low Range-Past and Present Production

The low end of the range for this cumulative analysis is 6 billion barrels (rounded), which includes past and present production (Tables V-7b and V-7c). This includes reserves (5.284 billion barrels) in currently producing fields (Table V-2) and resources (0.305 billion barrels) in discoveries in the planning or development stage (Table V-4). Sale 186 represents approximately 7.0% by reserve volume of the past and present production volumes (Table V-7b).

V.B.5.b(2) The Midrange - Past, Present, and Reasonably Foreseeable Future Production

The midrange for the cumulative analysis is 11 billion barrels (rounded), which includes past, present, and reasonably foreseeable future production. This includes the 6 billion barrels (rounded) from the low range (discussed above) plus discoveries that may be developed in the next 20 years. Reasonably foreseeable future production (5.62 billion barrels) consists of discoveries totaling 0.500 billion barrels onshore and 1.070 billion barrels offshore (Table V-7c). In addition, undiscovered onshore resources of 2.670 billion barrels in satellite accumulations and new fields in the National Petroleum Reserve-Alaska, plus 1.38 billion barrels from tracts expected to be leased on the outer continental shelf (Tables V-7b and 7c). Sale 186 Project represents about 4% by reserve volume of the past, present, and reasonably foreseeable future production (Table V-7b).

V.B.5.b(3) The High Range - Past, Present, Reasonably Foreseeable Future, and Speculative Production

The high range for the cumulative analysis is 15 billion barrels (rounded), which includes existing, planned, possible, and speculative production. This includes 11 billion barrels from the mid-range (discussed above) plus speculative future production (3.59 billion barrels), which includes undiscovered resources that may be developed after 20 years. Speculative production includes an estimated 2.300 billion barrels in currently undiscovered onshore resources in satellite fields and enhanced oil recovery (2.000 billion barrels), plus the remaining half of the leased and undiscovered volume in the northeast and northwest National Petroleum Reserve in Alaska (0.300 and 0.370 billion barrels respectfully) (Table V-7c). It also includes an estimated 0.92 billion barrels of undiscovered offshore resources that could be developed as a result of future Federal lease sales. Sale 186 represents about 3% by reserve volume to the total of past, present, reasonably foreseeable future, and speculative production (Table V-7b).

V.B.6. State Lease Sales We Consider in This Cumulative-Effects Analysis

Since December 1959, the State has held 32 oil and gas lease sales involving North Slope and Beaufort Sea leases. More than 4.6 million acres have been leased; some of the areas have been leased more than once, because some leases had 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, about 10% actually have been drilled, and about 5% have been developed commercially. About 78% of the leased areas are onshore, and about 22% are offshore. From the early 1960's through 1997, 401 exploration wells were drilled in State onshore and offshore areas. During this period, the number of exploration wells drilled annually has ranged from 2-35. From 1990 through 1998, the number of exploration wells drilled annually has ranged from about 7-12; the average number is about 10. Fifty-three of the exploration wells have resulted in discoveries—a success ratio of about 5%.

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. Except Northstar, all of the North Slope and Beaufort Sea's commercially producible crude oil is on 931 active State leases (as of December 2000): 1.35 million acres onshore along the Slope, 498,000 acres offshore in the Beaufort Sea, and 456,000 acres of active leases that straddle on and offshore acreage. All production to date is from State leases and totals 13.306 billion barrels (Table V-7a). The latest State lease sales, North Slope Area Wide and Beaufort Sea Areawide, were held in November 2002. Between 2001 and 2005, the State is expected to hold the following annual areawide lease sales:

- Beaufort Sea sales extending from Barrow to the Canadian border;
- onshore sales on the Arctic Slope, including unleased State lands between the Arctic National Wildlife Refuge and the National Petroleum Reserve-Alaska; and
- Foothills sale extending into the foothills of the Brooks Range.

The State has not estimated oil and gas resources for these future lease sales (see Table V-1c). As indicated above, we estimate 4.0 billion barrels in undiscovered resources on the North Slope. These include both leased and unleased State properties. Most are expected to be producible only as satellites through future field infrastructure.

V.B.7. Federal Lease Sales We consider in This Cumulative-Effects Analysis

We consider Federal OCS and northeast National Petroleum Reserve in Alaska lease sales in this analysis. Although no significant production has yet occurred from the Federal OCS off Alaska, possible future production from Sale 186 is estimated at 460 million barrels. As indicated, we also estimate speculative future production from the OCS of 3.42 billion barrels of currently undiscovered resources, from the base case of the MMS's 1995 National Assessment of the Beaufort Sea less production from "possible outer continental shelf projects"(Tables V-7b and V-7c). We estimate speculative future production from leases on the northeast National Petroleum Reserve in Alaska would be 0.50 billion barrels.

Since December 1979, the U.S. Department of the Interior has held seven lease sales in Federal waters of the Beaufort Sea. The latest, Sale 170, was held in August 1998. Overall, 660 leases have been issued in the Beaufort Sea totaling 2.8 million acres. About 30 wells have been drilled on these Federal leases, with 9 wells determined to be producible. All wells have been plugged and abandoned, however, because field economics have not favored production. There also are 42 active leases on Federal submerged lands in the Beaufort Sea; the Kuvlum and Hammerhead, which are potentially producible units although they are not currently leased (Figure III.A-1); there are no estimates of available resources. The Northstar Unit contains two Federal tracts. These tracts contain 20-25% of Northstar's estimated 158 million barrels of oil reserves.

Existing outer continental shelf leases in the Beaufort Sea are estimated to contain 220-550 million barrels of oil. The lower number represents potential development at $18/barrel. The higher number assumes a price of $30 per barrel, at which industry is likely to develop discovered but noncommercial fields such as Kuvlum, which is no longer active. Tracts available for lease in Sale 170 but not yet explored may contain 210-450 million barrels of oil.

The Bureau of Land Management held its most recent lease sale in the northeastern part of the National Petroleum Reserve-Alaska in June 2002. Overall, 60 tracts received bids with high bonus bids totaling $63.8 million. Assuming multiple sales, a speculative estimate of Northeast NRP-A production ranges from 130-600 million barrels of oil. Phillips has drilled 10 wells with announced discoveries of gas, oil, and condensate in five of six wells. Four wells, Lookout #2, Mitre, Hunter A, and Altamuna #2, are being drilled this winter.

V.B.8. Classified Drilling

In addition to the discoveries mentioned above, a number of wells have been drilled that are "classified" (or in field jargon, "tight holes"). If a well is termed classified, no information is released to the public. Presumably, some of these may include discoveries that may be developed in the future; however, without data, no useful estimate of their contribution to cumulative effects can be made.

V.B.9. Infrastructure and Transportation

Given the decline of resources in the fields surrounding Prudhoe Bay, the infrastructure and transportation system (including the Trans-Alaska Pipeline System pipeline) should be able to process and transport any oil that Sale 186 and other small projects produce. New fields would use infrastructure at the edge of the core area. These can be envisioned as the western sector or Alpine Group, which would accommodate the National Petroleum Reserve-Alaska; the central or Northstar Group; and the eastern sector or Badami Group (Figure III.A-1; Tables V-6a and V-6b).

The Trans-Alaska Pipeline System terminal at Valdez presently handles about 999,202 barrels of crude daily. At peak production, Sale 186 would produce about 19 million barrels of crude oil annually. The daily production rate from Sale 186 would be approximately 5% of the throughput the pipeline system now handles. If we estimate future production on the North Slope (including offshore) at the high end of projections, oil tankers still could be moving this daily amount of oil (about 1.0 million barrels) from Valdez in 2009.

V.B.9.a. Tanker Traffic and Routes

Potential crude oil (and possibly liquefied natural gas tankerage from Valdez) to the Far East will join existing liquefied natural gas tanker traffic from the liquefied natural gas plant in Nikiski, Alaska. Every

10 days, the Nikiski plant loads a tanker with 80,000-cubic meters of liquefied natural gas for a round trip to Tokyo, which it has been doing since 1968 without significant spillage. Because liquefied gas would boil off and disperse quickly when exposed to normal air temperatures and winds in the North Pacific, it is not a major environmental threat along the tanker route.

On November 28, 1995, President Clinton signed legislation (30 U.S.C. 185(s)) that authorizes exporting crude oil from Alaska's North Slope in U.S. flag tankers, unless the President finds exports are not in the national interest. Figure V-3 shows the probable route that tankers bound from Valdez to the Far East would travel. They could carry up to 1.8 million barrels each; however, such estimates are highly speculative, because they depend on opportunities for short-term contracts. The routing shown in Figure V-3 would bring the tankers more than 200 miles offshore of the Aleutian Islands—a distance that should protect the biological resources of the Aleutian Chain from pollution.

V.B.9.b. Trans-Alaska Gas-Transportation System

If the price per barrel of crude oil remains between $20 and $30, building a gas-transportation system may be viable. A variety of proposed systems could be designed to deliver natural gas from the North Slope at up to 2.3 billion cubic feet per day to a liquefaction plant in Valdez. The natural gas would be moved through a 42-inch pipeline built next to the Trans-Alaska Pipeline. The proposed project would consist of a plant to liquefy about 2 billion cubic feet of natural gas per day, four tanks to store 3,200,000 barrels of liquefied natural gas, a marine loading area, and a dock for loading cargo and personnel. The liquefied natural gas plant most likely would be in Anderson Bay, 3 miles east of the Valdez narrows on the south shore of Port Valdez (other options are being considered). The site is 3.5 miles west of the existing Trans-Alaska Pipeline System terminal and 5.5 miles from Valdez. When completed, it would occupy 390 acres of a 2,630-acre site owned by the State. A fleet of 15 liquefied natural gas tankers is anticipated would be available to carry 125,000 cubic meters of liquefied gas per trip to destinations in Japan, Taiwan, and Korea. Full development would require 275 liquefied natural gas tanker loadings a year (Federal Energy Regulatory Committee, 1995). A final EIS was issued for the plant in March 1995, but no agreements exist with the resource holders.

In the past year, industry has been studying a Trans-Alaska Gas System including proposals for the following: (a) over the northern part of Alaska and down the Mackenzie River through Canada and (b) follow the Haul Road south to Delta Junction and then through Canada. Although not as cost effective, the State Legislature and Congress both passed legislation requiring the gas pipeline to follow the Haul Road through Alaska to create jobs and provide gas to Alaskan communities along with way.

Please see Table V-1b for more information on the Trans-Alaska Gas System and other projects that could move gas from the North Slope to market. However, given the uncertainty associated with construction of such a transportation system in the foreseeable future, its potential effects are not included in this cumulative analysis.

V.B.9.c. Transportation for "Roadless" Development

Ongoing and planned oil-development projects such as Badami, Liberty, Alpine, and Northstar would not have permanent gravel roads connecting to Prudhoe Bay. Transportation to these fields would be by aircraft and marine vessels; in winter, temporary ice roads also would be used (Table V-8).

V.B.10. Water and Gravel Resources

V.B.10.a. Water Resources

The Arctic Coastal Plain is the predominant feature of the North Slope. It is a mosaic of tundra wetlands with extremely low relief and poor drainage and numerous shallow lakes, ponds, marshes, and slow-moving streams. Shallow permafrost is evidenced by polygonal-patterned ground formed by ice wedges that freeze within contraction cracks in the soil. Permafrost prevents water from entering the ground, and the low relief limits runoff. The coastal plain extends south approximately 30 miles into the coastal lowlands, which are dominated by tundra vegetation, meandering streams, and thousands of shallow thaw lakes.

Approximately 26% of the coastal plain is covered by waterbodies (USDOI, Bureau of Land Management, 1979). The onset of snowmelt and subsequent runoff begins earlier in the foothills and moves north as summer progresses. Snowmelt is a dominant factor, because it contributes the majority of the annual runoff and helps maintain a saturated layer of surface soils. Stream flow generally is nonexistent in the winter. It begins in late May or early June as a rapid flood event or "breakup" that, combined with ice and snow damming, can inundate extremely large areas in a matter of days. More than half of the annual discharge from a stream can occur during a period of several days to a few weeks (Sloan, 1987).

On the North Slope, the industry uses in the neighborhood of 1 billion gallons of water annually (Fay, 2001, pers. commun.). Freshwater is used for construction maintenance, on-tundra roads, and to provide a freshwater cap for the established sea-ice road. For example, a tundra ice road 50 feet wide, 6 inches in total thickness, and 6 miles long would require about 4.3 million gallons of water (Table V-9a).

There are numerous permitted water sources that may be used for ice-road construction and other water needs. These sources include existing and abandoned mine sites. Available permitted lakes range in size from approximately 0.1-0.5 square miles in surface area. The 120 million gallons of water would equal 368 acre-feet of surface (1.0 acre-foot = 326,000 gallons). This volume represents a water drawdown of 12 inches from a 368-acre lake or two smaller, 184-acre lakes. Two larger lakes, four smaller lakes, or some combination would accommodate a drawdown of 6 inches. The permitted lakes are available throughout the area and ideally located to minimize travel for construction and maintenance purposes (Maps 14a and 14b).

Water requirements for other onshore exploration and development during the seasonal construction phase have been estimated at about 37 acre-feet for each field, which would require water from an additional 12 acres of lake per field (U.S. Army Corps of Engineers, 1999).

Water volumes for tundra-ice roads are shown in Table V-9a. Total road thickness is about 6 inches, of which two-thirds of the thickness is freshwater and one-third is snow. Water volumes for sea-ice-roads consist primarily of saltwater. The sea-ice brine is capped with a 6-inch layer of freshwater for stability (Table V-9b). Ice roads have not been mapped from past activities. Effects have been described as "green trails," which may last for one to two seasons. Pressure from the weight of the snow and ice can cause some compression and breaking off of the older tundra vegetation and result in a spring burst or "greening" from the freed-up younger portions of the plant. The short duration of this visual effect has not been recorded, and past "green trails" are no longer visible. Projecting the need for ice roads for reasonably foreseeable projects is difficult at best. Many of these new developments will be developed as roadless sites.

Climatic change in terms of global warming should not be measurable, as any trends in global warming are on a greater scale than 10-15 years and would not be measurable in this shorter timeframe. If ice roads were to experience a shorter season of supportive cold temperature, the operations would be suspended accordingly or supported by helicopter similar to the roadless development sites.

The State of Alaska, Department of Fish and Game has long understood the importance of the overwintering habitat for freshwater fishes and the limitations of this habitat with an extensive ice cover and limited availability of dissolved oxygen for the duration of the extended winter seasons on the North

Slope. Lakes have been cataloged, and studies are continuing on inventorying and investigating lakes that also can accommodate industrial use. When permitting a lake for industrial use, conditions of the permit take into account draw down in relation to overwintering along with other criteria. If the waterbody is fish bearing, the Department of Fish and Game imposes a restriction: "no more than 15% of the total volume of water source may be withdrawn." Ice is excluded from the total volume calculation; therefore, the "15%" is of the available unfrozen water.

Temporary water-use permits are granted for a period of 1 day to 5 years. This usually covers the period of an exploration activity. There is, of course, no permanent designation for a freshwater source, because the environment is somewhat in a flux that could change the conditions of a permit. For its Trailblazer Project in the Petroleum Reserve, BPXA used 84.5 million gallons of water for ice-road and pad construction through April 2001 (Chambers, 2002). For the 1999-2000 and 2000-2001 drilling seasons, Phillips used 51 and 57 million gallons of water, respectively, from permitted sources in constructing roads and drill pads in the Petroleum Reserve. For more long-term needs, such as a production site, a lessee can file for water rights to a specific waterbody, such as the Duck Island mine site. These permitted waters presently are being used only for ice-road construction and, at this time, no other use is anticipated. The Duck Island mine site is expected to provide considerable freshwater, but other small lakes in the area could be permitted if needed. While the Sagavanirktok River would be an additional source of freshwater, the seasonal change in available water and concern for overwintering fish habitat would limit the availability of this resource.

Most of these resources have not been permitted for industrial use. Only those waterbodies in proximity of a construction or production site have been permitted. Most of those permitted sites are not used after the completion of a construction project, which can take from a few months to 1 or 2 years. None of these permitted sites have shown impacts, as the spring snowmelt and flooding restores the condition of these sites each year. There are no associated impacts from past and present activities to freshwater lakes and rivers, and none are projected with the current permitting process to occur in the foreseeable future. As development proceeds to the east and west of the current development sites, additional water resources will be assessed on a project-specific basis. Some construction activities, such as gravel mining, have created new water resources and associated habitat for biota, which has enhanced the diversity and productivity of these areas. Any new agreements or policies from the State Department of Natural Resources will encourage users to coordinate water withdrawals and gravel-extraction with the purpose of using gravel extraction sites as water reservoirs (State of Alaska, Department of Natural Resources, 2000).

Biotic communities present within the permitted freshwater lake systems are not expected to be adversely affected with these fluctuations in water level, as the natural environment and the dynamics of seasonal flux are more rigorous conditions that the biota has accommodated (see SectionV.C.7 Vegetation and Wetlands). Cumulative effects on water resources would not be expected, as local freshwater needs would be replaced by natural processes.

V.B.10.b. Gravel Resources

Permitted Gravel sources are indicated on Map 14a. In all three categories of gravel sources listed in the legend for Map 14a, the total amount of surface covered is 2,743 square miles, or 1,756 acres. Gravel in the area of Alaska north of the Brooks Range has been used for a variety of construction and maintenance purposes. These uses include construction of the following:

- "Haul Road"/Dalton Highway in support of the development of the North Slope oil fields and the Trans-Alaska Pipeline;
- pads for camps, exploration drilling, development and production drilling sites, and operations and maintenance facilities;
- airports in the oil-field area and in the communities of the North Slope Borough;
- roads in the oil-field area and in the communities of the North Slope Borough;
- manmade islands for offshore exploration drilling and development and production facilities;
- docks and causeways; and
- beach nourishment in several of the North Slope Borough communities.

From 1974-1999, more than 205 million tons of gravel have been mined to meet the industrial and community construction and maintenance needs in the area that the Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys refers to as the Northern Region. This area is north of 67° N. latitude and includes the Brooks Range, the area north of the Brooks Range to the Beaufort Sea coast (the North Slope and oil-field area), the Chukchi Sea coast north of Cape Krusenstern, and the North Slope Borough communities). Most of the gravel has been mined from the floodplains of the rivers in this area. About 88% (about 180 million tons) of the gravel was mined from 1974-1985. During this time the Haul Road/Dalton Highway and pads, roads, and airfields were constructed for the facilities to develop the Prudhoe Bay, Kuparuk River, Lisburne, Milne Point, and Endicott oil fields. Through 1999, these five fields produced about 12.5 billion barrels of oil; total production from all the North Slope oilfields through 1999 was about 12.9 billion barrels of oil. From 1986-1999, the amount of gravel mined annually in the Northern Region has ranged from 4.5-0.56 million tons.

The amount of gravel used in the State of Alaska from 1980-1985 was about 236 million tons and in the Northern Region from 1974-1985, it was about 180 million tons. Although the time periods are different, the information indicates that a large portion of the State's gravel usage was in the Northern Region to develop the oil fields. From 1986-1999, gravel usage in the State and on the North Slope was about 197 and 27 million tons, respectively; Northern Region gravel usage was about 14% of the State's total. From 1986-1999, the amount of gravel used in the State has ranged from about 21-9.8 million tons.

Users of the gravel have included the following:

- petroleum companies with oil and gas leases on the North Slope and in the Beaufort Sea and their contractors
- Bureau of Land Management
- North Slope Borough
- Alaska Department of Public Facilities and Transportation
- Arctic Slope Regional Corporation
- Alyeska Pipeline Service Company
- COMINCO (Red Dog Mine)

The area disturbed by gravel mines and fill placement is a fraction of the area north of the Brooks Range. The Arctic Coastal Plain covers about 230,000 square kilometers (23,000,000 hectares), and the area between the Colville and Canning rivers is about 71,000 square kilometers (7,000,000 hectares) (Gilders and Cronin, 2000). The area disturbed by gravel mines and fill placement is about 8,793 hectares; this is about 0.04% of the coastal plain and about 0.1% of the area between the Colville and Canning rivers.

Most of the area between these two rivers is owned by the State of Alaska. Gravel extraction from this area requires permits, and the Alaska Department of Fish and Game, Habitat and Restoration Division has developed guidelines for siting, design, operation, and reclamation of North Slope gravel pits. In general, North Slope gravel usage for the oil fields has been declining. Large fields, such as Prudhoe Bay and Kuparuk, which cover a large area requiring a large number of production facility pads, are not being discovered. Table V-10 shows that the unit area of the fields that began producing after 1981 or planned for future production ranges in size from about 2,000-34,000 hectares; the unit area for Prudhoe Bay and Kuparuk River fields was larger than 99,000 hectares. There also is a trend toward consolidating facilities and using technological advances that minimize the surface area disturbed (Gilders and Cronin, 2000). Gilders and Cronin (2000) estimate that if the original Prudhoe Bay discovery were to be developed today, the gravel fill required would cover only 617 hectares, and the contractor Deadhorse type service area (302 hectares) would not exist but would be consolidated with oil-company facilities as they are at Kuparuk.

West of the Colville river gravel sources are far more difficult to locate. Surface deposits within the National Petroleum Reserve-Alaska consist mostly of fine-grain clay, silt, and sand. Gravel is located along the slopes of the Brooks Range, the Colville riverbed and some scattered areas along the arctic coast. Long hauls are often required to bring in gravel, and gravel from existing work/drill sites is repeatedly reused (U.S. Geological Survey, 1985). This lack of gravel will be a significant consideration in the development of permanent oil and gas facilities west of the Colville River.

In addition to the production facilities that are designed and constructed for several decades of use, oil and gas activities on the North Slope include exploratory drilling. Exploratory drilling must be done to find oil and gas reservoirs and generally lasts for only a few months at any specific site. From 1944-through 2001 a total of 344 exploratory wells have drilled on state onshore and offshore leases as well as private lands north of 68° N. latitude. Since the beginning of Federal activity in the Beaufort Sea, 30 wells were drilled in Federal Beaufort Sea waters. Since the beginning of drilling operations in the Petroleum Reserve (in 1944) 77 wells have been drilled. These figures are for actual exploratory wells as opposed to wells drilled principally to acquire strata core samples (Ryherd, 2002, pers. commun.). Most of these wells probably were drilled from a gravel pad, and many exploration sites included a gravel airstrip; where freshwater was available, an ice pad and airstrip could have been constructed. Exploratory wells that were drilled in the Federal (OCS) waters of the Beaufort Sea were drilled from a variety of structures that included gravel and/or ice islands, drillships, mobile bottom-founded drilling units (concrete island drilling structure, single steel drilling caisson) and a cone-shaped drilling unit (Kulluk).

Other developments that have reduced the amount of gravel needed to develop or maintain oil and gas production facilities include:

- ice pads instead of gravel for exploratory well-drilling pads (onshore and offshore in shallow waters, where appropriate);
- use of mobile steel or concrete mobile bottom-founded structures to drill exploratory wells in shallow waters;
- use of ice roads instead of gravel roads for pipeline construction;
- developing fields without a gravel road connection to Prudhoe Bay/Deadhorse area (Badami and Alpine);
- reducing the spacing distance between development wells, which reduces the size of the development pads (The Alaska Department of Natural Resources estimates a 76% reduction in development pad size (State of Alaska, Department of Natural Resources, 1991);
- use of extended-reach drilling, which reduces the amount of gravel needed to develop new reservoirs that lie near established facilities;
- recycling of gravel from roads, airfields, or pads that are not used; and
- use of clean drill cuttings in place of gravel.

In addition to reducing the amount of gravel needed, other developments that reduce the amount of surface area disturbed include underground injection of drilling muds and the elimination of reserve pits (may be needed at times on a temporary basis).

In addition to the oil fields and Deadhorse, the boundaries of the North Slope Borough include eight communities with populations that range from about 200 to more than 4,400. All of these communities have airfields and roads constructed with gravel.

V.C. ANALYSIS OF CUMULATIVE EFFECTS BY RESOURCE

Assumptions Used in the Analysis: The analysis of cumulative effects differs from the analysis of Alternative I for Sale 186, in part because it considers an expanded geographic area and extended timeframe. This is needed to include additional effects on the physical, biological, and human environments of development of the oil and gas discoveries and other activities described in Section V. The geographic area is further expanded to include the migratory and transitory nature of many resources. The timeframe includes development of discoveries that may occur during the next 15-20 years and exploration activities for new discoveries over the next 30-40 years.

The cumulative-effects analysis further differs from the alternative effects analysis by assessing the combined effects of past, present, and reasonably foreseeable future activities. To determine the effects of the alternatives (Section IV.C), we used the existing environment (Section III), as a baseline. However, this is not appropriate for cumulative-impact assessments, because it makes the effects of past and present actions part of the baseline rather than contributing to cumulative impacts (McCold and Saulsbury, 1996). The National Environmental Policy Act requires us to describe the incremental contribution of Alternative I for Sale 186 to the existing baseline at the present time. This baseline changes over time with additional uses, and the National Environmental Policy Act also requires an accounting of the environment over time. This means that our baseline for this cumulative-effects analysis must include past, present, and reasonable foreseeable activities. In the cumulative analysis, the incremental contribution of the proposed activity is relatively small and may be further reduced in significance as new activities are factored in. There is, however, greater uncertainty in determining cumulative effects than in determining the individual project-specific effects. We recognize the importance of ongoing environmental change and attempt to quantify the factors causing this change, including recovery, and identify thresholds of environmental response, when possible.

While this EIS evaluates the potential effects of holding three proposed lease sales (186, 195, and 202) in the Beaufort Sea, the decisions that follow the completion of the EIS will focus on each individual sale. The first decision will be whether to hold Sale 186 as proposed, or modify the area offered, or to not hold the sale at all (the No Action Alternative). Therefore, the cumulative analysis that follows will evaluate the contribution of Alternative I for Sale 186 to the cumulative effects. For analysis purposes, Sale 195 and 202, are considered to be part of the reasonable and foresee activities that may occur.

The major focus of the cumulative analysis for Alternative I for Sale 186 will be the contribution to the near shore area, which is expected to see more than 70% of the projected leases and two thirds of exploration activity and development projects (Map 4). This relatively small nearshore area represents only about 4% (0.38 million acres) of the total sale area which, along with Endicott, Northstar, and Liberty, assumes a doubling in activity (see USDOI, MMS, Alaska OCS Region, 2002a:Maps 3a and 3b, North Slope Oil and Gas Fields). However, in some cases this area of greatest potential increase in effects for the cumulative analysis is only a small percentage of the habitat for some wide-ranging resources transient to the area.

The area of medium depth and distance from the present activity base represents about 28% (2.7 million acres), while the far area in deeper water represents about 68% (6.7 million acres) of the total sale area (9.8 million acres). These two much larger areas will increase the range of potential effects for some resources but are not expected to increase present ongoing effects in a cumulative analysis. Any effects to resources occurring in these vast outlying areas as a result of noise and disturbance would be expected to have recovered prior to any subsequent disturbance event in the nearshore area. Most resources would not be expected to encounter two similar disturbance or oil-spill events when considering the unlikelihood of two independent events occurring in time and space to the same resource or prior to recovery.

Alternative I for Sale 186 is expected to add two development projects in the nearshore area of greatest industrial activity. While the incremental concentration of Sales 195 and 202 and other reasonable and foreseeable activities are similar, the resulting activities are fewer and more concentrated as exploration and development activities take place further away from the established infrastructure. In addition to and for the same reasons given, additive or synergistic effects would not be expected to occur as a result of Alternative 1 for Sale 186 to other reasonable and foreseeable developments.

A key element in oil-spill analysis is an assessment of risk. Risks are unarguably contentious. One of the fundamental problems when using quantitative risk analysis is related to the way the results of the analyses are expressed and interpreted. People evaluate risks in incompatible ways, based on their value systems (Thompson and Dean, 1996) and their perceived degree of exposure to a potential risk. Oil spills have high levels of “dread potential” (Slovic, 1987) because of their potential to produce consequences in the event of accidents, even though such occurrences have been estimated to have low occurrence probabilities. The MMS recognizes that some stakeholders may wish to reduce the chance of a spill occurring, while others may consider any chance of a spill occurring as unacceptable. Still others may find the small chance of a spill occurring as an acceptable tradeoff for the benefits derived from oil and gas production.

To calculate the likely number of estimated oil spills in our analysis of cumulative effects, we decided to use the midrange production estimate, which includes our estimate of past, present, and reasonably foreseeable future production for the North Slope/Beaufort Sea (Table V-7b). The incremental contribution of Alternative I for Sale 186 by volume of oil is a small portion (about 4%) of the midrange production estimate. To determine the number of oil spills, we multiply the offshore and onshore reserve estimates by the spill rate per billion barrels produced. While the most likely number of offshore oil spills greater than or equal to 500 barrels from all past, present, and reasonably foreseeable future activities is estimated to be zero, the most likely number of spills from Alternative I for Sale 186 is zero (Table V-12). The mean number of estimated offshore spills for the Beaufort Sea offshore area statistically is 0.65, of which Alternative I for Sale 186 is estimated to contribute statistically only 0.11, or about 17 %. While the number of spills may vary as a result of new resource estimates and assumptions, the relative contribution of Sales 195 and 202 is expected to be the same or proportionally smaller.

The most likely number of onshore oil spills greater than or equal to 500 barrels from all past, present, and future activities is estimated to be five, the most likely number of spills from Alternative I for Sale 186 is estimated to be five (Table V-12). The mean number of estimated onshore spills for the North Slope area statistically is 5.59, of which Alternative I for Sale 186 is estimated to contribute statistically only 0.05 or 0.8%. The most likely number of pipeline oil spills greater than or equal to 500 barrels is estimated to be 1.24; the most likely number of spills from Alternative I for Sale 186 is estimated to be 5 (Table V-12). The mean number of estimated pipeline oil spills statistically is 1.24, of which Alternative I for Sale 186 is estimated to contribute statistically only .05 or 4% (Table V-13).

Analysis of possible oil spills from tankering oil to the West Coast includes consideration of the *Exxon Valdez* oil-spill effects in Prince William Sound, a large spill in the Gulf of Alaska, and smaller spills along the tanker route. The most likely number of oil spills greater than or equal to 1,000 barrels from Trans-Alaska Pipeline System tankers is 10, and the most likely number of spills from Alternative I for Sale 186 is estimated to be zero. The mean number of estimated spills is 10.07, of which Alternative I for Sale 186 is estimated to contribute statistically only 0.41, or about 1.5%. We estimate 6 spills with an average size of 4,000 barrels, four of which occur in port and two at sea. We assume two spills with an average size of 13,000 barrels, both, which occur at sea. Finally, we assume one at-sea spill in the Gulf of Alaska of 250,000 barrels.

In-port spills, where contingency measures are in place, would be cleaned up relatively quickly. Spills originating 80-100 nautical miles offshore would have a 5-10% chance of contacting the shoreline within 30 days (LaBelle and Marshall, 1995). Recent new shipping lanes and port routes have been initiated by the National Oceanic and Atmospheric Administration requiring tankers to travel at least 50 nautical miles offshore central California to better protect three marine sanctuaries of Monterey Bay, the Gulf of the Farallones, and the Channel Islands. The estimated six spills at sea and the one larger spill are not expected to occur within the same location or contact the same resources before recovery of the affected resource. Recovery periods would be lengthened if more than one spill affected the same population within a short interval, an unlikely situation.

Monitoring studies are available of biological populations that have experienced past and are experiencing present industry activities. However, where available, they have been factored into the abundance and distributional status and trends of the populations. Natural population fluctuations also are an important consideration but often are not well defined because of the extensive habitat and wide-ranging migratory patterns of many arctic species. Some populations, such as polar bears and some caribou herds have increased over the past 30 years while others, such as the spectacled eider, have decreased. However, the exact causes of these population changes are difficult to determine.

With the somewhat ubiquitous distribution of many of the resources on the North Slope, an overlap of impact zones from activities of several projects is not well defined. Figures III.B.3a and III.B.3e show the distribution of ringed seals and polar bears. Caribou calving areas in northern Alaska also are shown in Figure III.B-4. Nonmobile populations, such as those comprising the Boulder Patch in the Beaufort Sea, could be more heavily affected by specific projects. In this case, the Endicott and Northstar projects are weighed more heavily. Also, oil spills and disturbance factors are highly unlikely to occur at the same time and place to increase the magnitude of effects. Thus, for the most part, resources are expected to have recovered from a perturbation before providing any measurable increase in cumulative effects.

The analysis of each resource has been weighed with respect to past, present, and future activities, as appropriate, to best predict the effects of Alternative I for Sale 186 on that resource. For instance, the threatened spectacled eider has experienced stress from past and present environmental factors and human activities, and this stress is likely to continue in the future. Thus, the effects from offshore leasing in the Beaufort Sea on these eiders are of concern. Effects from past oil and gas activities and those presently ongoing are part of the present population condition.

As indicated above, future actions resulting from the development of existing discoveries are on a certainty scale of past development (those currently in production), present development (within 10 years), reasonably foreseeable future developments (within 10-20 years), and speculative development (after 20 years). The most heavily weighed are those past and present activities onshore at Prudhoe Bay, the Kuparuk River, Milne Point, and offshore at Badami, Endicott, Sagavanirktok Delta, and Northstar. Next in consideration of offshore activities are the reasonably foreseeable future developments at Kalubik, Liberty, Thetis Island, Sandpiper, Kuvlum, Hammerhead, and Flaxman Island. Reasonably foreseeable future onshore developments could consist of seven relatively small fields of no measurable consequence to the environment at this time (Table V-1a).

Speculative future development after 20 years is highly uncertain and includes 13 smaller onshore discoveries, and some exploration and development activity resulting from future State and Federal lease sales has been included (see Section V.C). While future projections are highly speculative, effects are based on present state-of-the-art technology. Industry has been developing technology and strategies to reduce the impacts associated with exploration and development activity, and it seems reasonable to expect this trend to continue. Thus, future impacts might be less than are estimated in this cumulative analysis. Further, in the event of a major oil spill, additional design criteria, safeguards, and protective measures would be instituted as evidenced by the *Exxon Valdez* oil spill. For purposes of analysis, we have assumed no additional mitigation that would be very unlikely and, in that respect, this analysis overestimates cumulative effects.

Analysis of Cumulative Effects by Alternative: The NEPA Council on Environmental Quality regulations recognize the cumulative problem as complex and requires, along with Alternative I for Sale 186, an analysis of cumulative effects. Because the incremental contribution of a proposed action usually is small and each new project can affect or add to the baseline condition, Congress covered this contingency with the cumulative analysis. The purpose of the analysis was a consideration of where we had been and where we were going with development of our resources. This analysis is on a scale of projects past and present and in the reasonably foreseeable future in the next 15-20 years. This scale puts in perspective the sensitivity of the cumulative analysis. This means that impacts that can be identified in the analysis of a proposed project might, or more than likely, might *not* translate to an effect in the cumulative analysis.

An example of scale is the lease-sale EIS, which usually involves major tract-deletion alternatives. These usually are measurable differences for some resources, but for many resources there is no change in the effects of the alternatives from the proposed action. The cumulative effects for each alternative, even in these large lease-sale areas in Alaska, have never been considered to yield any useful information, because there has never been a measurable effect of an alternative at the cumulative level. The resource levels (460 million barrels) and assumed exploration and development activities for Alternative I for Sales 195 and 202 are the same or less than those assumed for Alternative I for Sale 186. The number of platforms and the number of fields to be developed, in addition to the amount of activities occurring simultaneously, are less for Sales 195 and 202. Therefore, the contribution of those sales to the cumulative effects analysis likely would be very similar in scope and the same or smaller in size than those identified for Alternative I for Sale 186.

The extended geographic scale and timeframe of the cumulative analysis reduces the sensitivity of this analysis and treatment of alternatives. In the case of migratory birds, fishes, and mammals, the extensive geographic range of some of these species includes factors far removed from the site of the proposed action that can be limiting to the resource that spends but a small part of its time in the zone of influence of Alternative I for Sale 186. When projecting the past and future impact on the resource, the extended timeframe further reduces the sensitivity of the cumulative analysis to the importance of the proposed action; it is even less likely to detect a measurable change from the respective alternatives, which are proposed for the Alternative I for Sale 186.

In summary, Alternatives III through VI, evaluated in this EIS have not been analyzed for cumulative effects, because we are confident that there would be very little change in the level of effects identified for the alternatives to the proposed action. This is to be expected, because the level of impacts for Alternative I is very small in absolute terms and even smaller relative to an effect of past, present, and reasonably foreseeable future activities. By comparison, the difference between effects of Alternative I and effects of

Alternatives III through VI are even smaller. The measurable effects of Alternative I for Sale 186 do not necessarily translate to measurable effects in the cumulative analysis because of the larger scale and timeframe required for the cumulative analysis. The alternatives offer some change in the level of effects, but this is not measurable in the cumulative analysis. For these same reasons we use the cumulative analysis for Alternative I for Sale 186 as a very good approximation of the cumulative analysis for Alternative I for Sales 195 and 202. To do a separate but essentially identical cumulative analysis for Alternative I or any of the other alternatives for these two sales would disregard the NEPA mandate to focus on issues of importance.

Supporting Information: The following cumulative analysis builds on information contained elsewhere in this EIS. Section IV.C contains our analyses of potential effects. Section III describes the existing environment. Section IV.I provides analyses of low probability, very large oil spills from blowouts and tankers. Appendix A, Oil-Spill-Risk Analysis, explains and provides information used by the analysts for estimating the probabilities and locations of potential oil spills used in this EIS, including information about the size, location, and distribution of tanker spills.

As noted in Section II.A.4, the revised *Oil Discharge Prevention and Contingency Plan* prohibits the drilling of new wells or sidetracks from existing wells into major liquid hydrocarbon zones at its drill sites during the defined period of broken ice and open water (BPXA, 2001). This period begins on June 13 of each year and ends with the presence of 18 inches of continuous ice cover. This drilling moratorium eliminates the environmental effects associated with a well blowout during drilling operations in the Beaufort Sea during broken-ice or open-water conditions.

We also have evaluated the cumulative effects on the North Slope and from transporting North Slope oil to U.S. West Coast and Asian markets in the Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002 Final EIS (USDOI, MMS, 1996f:IV-264-464); Northeast National Petroleum Reserve-Alaska, Final EIS (USDOI, Bureau of Land Management and MMS, 1998:IV-H-1-26); Beaufort Sea Planning Area Oil and Gas Lease Sale 170, Final EIS (USDOI, MMS, 1998:IV-G-1-31); and, the Beaufort Sea Planning Area Oil and Gas Lease Sale 144 Final EIS, (USDOI, MMS, 1996a:IV-H-1-31).

Significant Cumulative Effects for All Resources: The MMS does not expect any significant cumulative impacts to result from any of the planned activities associated with the exploration and development of North Slope and Beaufort Sea oil and gas fields. Significance thresholds are discussed in Section III.A.1.a and significant impacts are defined in Section III.A. In the event of a large offshore oil spill, some significant adverse impacts could occur to spectacled eiders, long-tailed ducks, common eiders, subsistence resources, sociocultural systems, and environmental justice. However, the probability of such an event combined with the seasonal nature of the resources inhabiting the area make it highly unlikely that an oil spill would occur and contact these resources. Spectacled eiders, long-tailed ducks, and common eiders are present on the North Slope for only 3-5 months out of the year. A resource may be present in the area but may not necessarily be contacted by the oil. An oil spill could affect the availability of bowhead whales, or the resource might be considered tainted and unusable as a food source. The potential for adverse effects to some key resources (bowhead whales, subsistence, the Boulder Patch, polar bears, and caribou) is of primary concern and warrants continued close attention. Effective mitigation practices (winter construction, an advanced leak-detection system, thick-walled pipeline designs, etc.) also should be considered in future projects.

As noted in Section III.A.1, the MMS does not expect any significant impacts to result from any of the planned activities associated with Alternative I for Sale 186 or any of the alternatives. Significant adverse impacts to spectacled eiders, common eiders, long-tailed ducks, subsistence harvests, sociocultural systems, and to environmental justice would occur in the unlikely event of a large oil spill. The contribution to the development of North Slope and Beaufort Sea oil and gas fields is relatively small. For the cumulative analysis, the MMS estimates oil reserves and resources to be 11.1 billion barrels; the contribution of Alternative I for Sale 186 to this estimate is 460 million barrels, or about 7%. Also, the proposed level of infrastructure and facilities proposed for Alternative I for Sale 186 (Table V-5) are low compared to the levels associated with past development (Table V-3).

Summary of Cumulative Effects by Resource: A brief summary of the effects from Alternative I for Sale 186 and the relative contribution of those effects to other past, present, and future activities are presented in Table V-11. The more detailed analyses are found in Sections V.C-1 through 13.

In the following sections, we analyze the potential cumulative effects to individual resources. Each subsection consists of a cumulative analysis; a summary, conclusion, and discussion of incremental contribution; and a discussion of transportation effects along the transportation route.

V.C.1. Water Quality

Cumulative effects on water quality would be due primarily to three factors: discharges of drilling muds, cuttings and produced waters; construction of gravel islands and pipeline trenches; and oil spills. The Liberty Final EIS contains a detailed cumulative assessment of these three factors on water quality (USDOI, MMS, Alaska OCS Region, 2002a:Section V.C.12.b). The following is an updated summary of the cumulative effects on water quality due to the proposed Beaufort Sea lease sales.

The greatest effect on water quality from gravel-island and pipeline construction and pipeline repair would be additional turbidity caused by increases in suspended particles in the water column. Increases in turbidity generally are expected to be considerably less than the 7,500 parts per million suspended solids that are used in the analysis as an acute (toxic) criterion for water; exceptions may occur within the immediate vicinity of the construction activity. Turbidity increases from construction and repair activities generally are temporary and expected to occur during the winter and end within a few days after construction is completed. Material excavated from the pipeline trench but not used for backfill most likely would be left in an area where active erosion of sediment particles could occur during breakup and open water. The contribution of this material to the natural turbidity is expected to be about the same as the sediments existing at the seafloor surface before being covered. Effects of construction and storms would be additive but not synergistic because the turbidity from construction would be similar to the natural turbidity from storms. Future repair activities are not expected to introduce or add any chemical pollutants.

If the discharge of produced waters is permitted, the waters may be a few degrees warmer than the seawater and contain hydrocarbons. The discharged water also may contain some chemicals that have been added to prevent some types of biological and chemical activities. Permitted discharge systems would be designed to ensure rapid mixing and dilution of the discharge.

Oil spills from oil and gas development activities would degrade the marine environment through the release of petroleum hydrocarbons. The spills would increase the concentration of hydrocarbons in the water column. For the assumed oil spill (Table V-12), hydrocarbon concentrations could exceed the 1.5-parts per million acute-toxic criteria for about a day in an area of about 2 square kilometers (0.8 square mile). The 0.015-parts per million chronic criteria also could be exceeded for 10 or more days in an area of about 12-45 square kilometers (4.6-17.4 square miles). Hydrocarbon concentrations could exceed the 1.5-parts per million acute-toxic criterion for less than a day in an area less than a few square kilometers for small spills. The 0.015 parts per million chronic criteria also could be exceeded for less than a month in an area less than 100 square kilometers (39 square miles) for small spills. Therefore, a very large crude oil spill significantly would affect water quality by increasing the concentration of hydrocarbons in the water column to levels that greatly exceed background concentrations; however, the chance is extremely low of a large spill occurring, even in the cumulative case. If a spill did occur, regional (more than 1,000 square kilometers [386 square miles]) and long-term (more than 1 year) degradation of water quality to levels above State and Federal criteria is very unlikely.

Transportation Effects: Oil produced from Alternative I for Sale 186 is expected to contribute only a small fraction of cumulative oil spills from Trans-Alaska Pipeline System tankers (about 1%). However, future tanker spills of arctic oil, which may include oil from Alternative I for Sale 186, would be likely to adversely affect water quality in Prince William Sound, if spills occurred there. If some of these spills were to occur close enough to shore, they also would be likely to adversely affect water quality in the Gulf of Alaska along the tanker route. One of the future oil-tanker spills is assumed to be (for purposes of analysis) at least 250,000 barrels. Based on the assumptions for this EIS, the cumulative effects of tanker spills on water quality are summarized here. Assuming that some of the spilled oil contacts the nearshore areas (Prince William Sound or the Gulf of Alaska) in a relatively nonweathered state, a 250,000-barrel oil spill is estimated to affect up to 10% of the water quality within the affected area. Recovery is expected to take 1 or 2 days in areas with high surf energy and up to 1 week in embayments.

Conclusion: A spill could affect water quality for 10 or more days in a local area. The effects of discharges and offshore construction activities are expected to be short term, lasting as long as the individual activity, and have the greatest impact in the immediate vicinity of the activity.

Contribution of Alternative I for Sale 186 to Cumulative Effects: Levels of activities estimated for Alternative I for Sale 186 are used to estimate the contribution to the cumulative effects. There are more than 40 projects in the past, present, and reasonably foreseeable future development/production projects, 17 of which would be offshore prospects. Most of the 17 projects would be located completely offshore; however, 6 of the projects are or might be developed from onshore facilities. The contribution from Alternative I for Sale 186 to the total number of offshore projects (11) is about 9%. Therefore, we assumed that Alternative I for Sale 186 would contribute about one-tenth of the cumulative effects described in the previous paragraph.

V.C.2. Lower Trophic-Level Organisms

This assessment is based on the cumulative effects of offshore oil spills to coastal plankton and of disturbance and discharges on benthos. One offshore oil spill is estimated for this cumulative analysis (Table V-12). The spill risk to coastal plankton is due partly to two existing developments with offshore facilities—Endicott and Northstar. The risk also would be due to several reasonably foreseeable developments with offshore facilities—Liberty, Sandpiper, Flaxman, Stinson, and Hammerhead/Kuvlum. About half of these developments and prospects would be outside of barrier islands (including Northstar, Sandpiper, and Hammerhead/Kuvlum, slightly reducing the cumulative risk to coastal plankton. Further, one of the prospects (Liberty) inside of the barrier islands would be near the Boulder Patch kelp habitat, and the cumulative spill risk to kelp would be slightly greater than for only the Beaufort Sea Sales 186, 198, and 202.

In the cumulative sense, additional benthos would be buried by construction of offshore pipelines and islands. One of the reasonably foreseeable or proposed developments (Liberty) would be near the Boulder Patch and, therefore, the cumulative risk of disturbance to kelp would be slightly greater than Alternative I for Sale 186. With regard to typical benthos, the total amount buried during pipeline construction can be estimated from the approximately 100-acre footprint for the Liberty pipeline trench. For all of the reasonably foreseeable developments, the pipeline footprints probably would be less than 400 acres total, and the cumulative effects of disturbance on typical benthos would be very small. An old exploration island exists for two of the reasonably foreseeable developments (Liberty and Sandpiper); however, islands might be constructed for three additional developments over the next decade or so (Flaxman, Stinson, and Hammerhead/Kuvlum). The total amount of benthos initially covered by these islands probably would be less than 200 acres. When Seal and the old Northstar islands were abandoned and allowed to erode outward, they doubled their footprints (Coastal Frontiers Corp, 2000); therefore, about 400 acres of benthos probably eventually would be covered. These effects on typical benthos would be moderated by benthic colonization on old exploration islands that were abandoned during the past decade (for example, BF-37, Tern, Mukluk, and the old Northstar).

The estimated cumulative number of offshore oil spills over the assumed 15- to 20-year production life of Sale 186 is shown in Table V-12. The estimated mean number of offshore spills greater than 1,000 barrels is 0.54 for all past, present, and reasonably foreseeable activities. Alternative 1 for Sale 186 would contribute an estimated 0.11 spills, bringing the total mean number to 0.65 spills. Even though the total mean number is less than one, we assumed one spill greater than 1,000 barrels for the sake of the cumulative analysis. The assumed spill number and size for the cumulative assessment is similar to the assumed spill number and size that was assessed in Section IV.C for Sale 186; therefore, the spill effects would be similar. As concluded in Section IV.C.2.a(3), such a spill would have lethal and sublethal effects on less than 1% of the planktonic and benthic organisms in the sale area and less than 5% of the epontic organisms in the sale area. The effect of oil that drifts to shore and contacts intertidal biota is discussed further in Section V.C.9.b. The moderation of the benthic effects means that some cumulative effects might counteract one another but probably would not be additive or synergistic.

Transportation Effects: Oil produced from Alternative I for Sale 186 is expected to contribute only a small fraction of cumulative oil spills from Trans-Alaska Pipeline System tankers (about 1%). However, future tanker spills of arctic oil, which may include oil from Alternative I for Sale 186, would be likely to adversely affect lower trophic-level organisms in Prince William Sound, if spills occurred there. If some of these spills were to occur close enough to shore, they also would be likely to adversely affect lower trophic-level organisms in the Gulf of Alaska along the tanker route. One of the future oil-tanker spills is assumed to be (for purposes of analysis) at least 250,000 barrels. Based on the assumptions for this EIS, the cumulative effects of tanker spills on lower trophic-level organisms are summarized here. Assuming that some of the spilled oil contacts the nearshore areas (Prince William Sound or the Gulf of Alaska) in a relatively nonweathered state, a 250,000-barrel oil spill is estimated to harm up to 10% of the coastal organisms within the affected area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. The spill also is estimated to harm up to half of the affected intertidal and shallow subtidal marine plants and invertebrates. Recovery of these communities is expected to take 2-3 years in high-energy habitats and up to 7 years in lower energy habitats. Less than 5% of the subtidal benthic populations are expected to be affected.

Conclusion: One offshore oil spill greater than 1,000 barrels is assumed for the past, present, and reasonably foreseeable developments. About half of the reasonably foreseeable developments would be outside of the barrier islands, and the cumulative risk to river deltas and other sensitive portions of the coastline would not increase proportionally. Also, none of the developments other than possibly Liberty would be near the Boulder Patch and, therefore, the cumulative risk to it would be slightly greater with Alternative I for Sale 186. Benthos would be disturbed (buried) during pipeline and island construction for the reasonably foreseeable developments. The total disturbed area would probably be less than 800 acres, and the effect would be moderated by benthic colonization on old exploration islands that were abandoned during the past decade.

Contribution of Alternative I for Sale 186 to Cumulative Effects: We do not expect the cumulative effect of oil spills or disturbances from offshore developments (including any from Alternative I for Sale 186) to substantially affect organisms at the lower trophic level. For this reason, and because Alternative I for Sale 186 itself is estimated to contribute only about 4% of the estimated amount of oil spills to the cumulative case, Alternative I for Sale 186 is not expected to make a measurable contribution to the cumulative or synergistic effect on these organisms.

V.C.3. FISH

As discussed in detail in Section V.C, four categories of oil- and gas-related projects currently exist within the sale area. See Section V.B.1 for information about the projects in each category.

Each of these projects involves different types and amounts of oil and gas related activity that could affect fish populations. This applies equally to other future onshore oil and gas projects, such as those that may occur to the west of the Colville River (for example, the National Petroleum Reserve-Alaska). In general, the effects generated by these activities on fishes fall into two categories: those associated with disturbances, and those associated with exposure to oil spills. The following discussion briefly considers each of these.

V.C.3.a. Disturbances from Exploration, Development, and Production Activities

Fishes are sensitive to noise changes between 5-1,000 Hertz (Bell, 1990). Noise-producing activities from aircraft and vessels (summer) plus ice-road transportation (winter) would increase with many of the projects listed above. Those having activities in the nearshore area (for example, Kalubik, Sag River, Northstar, Niakuk, and Stinson) are likely to have the greatest effect on marine and anadromous fish populations. Onshore projects (for example, those associated with the Petroleum Reserve, Kuparuk, West Sag, Hemi Springs, and Yukon Gold) are likely to have the greatest effect on freshwater and anadromous fish populations. As mentioned in Section IV.C.1.a, noise effects on fishes could include local avoidance of seismic surveys, aircraft and vessel traffic, drilling and construction, and production operations. Also, some overwintering fishes may not be able to avoid noise and disturbances. However, noise associated with the projects mentioned above is not likely to have a measurable effect on fish populations, even if several are occurring at the same time. The wide distribution and low density of fishes, the short-term and mild nature of their response to noise associated with oil and gas activities, and the wide distribution and low density of likely oil and gas projects is the basis for this conclusion.

V.C.3.b. Effects of Discharges from Additional Drilling and Associated Oil and Gas Activities

The effect of the additional drilling and discharges associated with Alternative I for Sale 186 is likely to be local and temporary. These activities are not likely to contribute a measurable additive effect on fish populations. Fishes would be displaced from the areas where drilling equipment is installed, but this would affect only a very small area of the Beaufort Sea and would have no measurable cumulative effect on fish populations. The wide distribution and low density of fishes, the short-term and mild nature of their response to drilling and discharges associated with oil and gas activities, and the wide distribution and low density of likely oil and gas projects is the basis for this conclusion.

V.C.3.c. Effects from Pipeline Construction

Pipeline construction would kill small numbers of epibenthic invertebrates that fishes feed on. Trenching temporarily could alter the migration patterns of some migratory fishes, if the trenching occurred during migrations. However, epibenthic invertebrates quickly recolonize disturbed areas, and only minor changes in migration routes would be likely. Hence, measurable cumulative effects on fishes due to pipeline construction are not likely.

V.C.3.d. Effects from Cumulative Oil Spills

The cumulative effect of oil spills occurring and entering offshore waters on arctic fishes (including incidental anadromous species) would depend on the number of spills; the season of the year; and the hydrocarbon concentration, time of exposure, and stage of fish development involved for each spill encountered. However, mortality caused by a petroleum-related spill is seldom observed outside of a laboratory environment. Sublethal effects are far more likely, and these may include changes in growth, feeding, fecundity, and temporary displacement. In summer, the nearshore waters of the Beaufort Sea are used for migration and feeding by fishes. A small number of fish in the immediate area of an offshore summer spill could be killed or harmed; however, they would not be likely to have a measurable effect on fish populations.

V.C.3.d(1) Offshore Oil Spills

All past, present, and reasonably foreseeable oil spills for the cumulative analysis are estimated in Table V-12. For offshore spills, the estimated mean number of oil spills for all oil-related actions over the 15- to 20-year life of the sale (past, present, and reasonably foreseeable) is .54. Alternative I for Sale 186 is estimated to contribute .11 to this, bringing the total mean number of oil spills to less than one, or .65. The most likely number of offshore spills (greater than 1,000 barrels) that would be contributed by Alternative I for Sale 186 is zero.

As discussed in Section IV.C.1.b, Alternative I for Sale 186 assumed (for purposes of analysis) a 4,600-barrel pipeline spill or a 1,500-barrel platform spill. If either of these spills occurred and contacted the nearshore area, some marine and migratory fish may be harmed or killed. However, neither oil spill would be likely to have a measurable effect on marine and migratory fish populations, and recovery would be likely in 5-10 years.

V.C.3.d(2) Onshore and Trans-Alaska Pipeline System Pipeline Oil Spills

All past, present, and reasonably foreseeable oil spills for the cumulative analysis are estimated in Table V-12. For onshore spills, the estimated mean number of oil spills for all oil related actions over the 15- to 20-year life of the sale (past, present, and reasonably foreseeable) is 5.54. Alternative I for Sale 186 is estimated to contribute .05 to this, bringing the total mean number of oil spills to 5.59. The most likely number of offshore spills and Trans-Alaska Pipeline System pipeline spills (greater than 1,000 barrels) that would be contributed by Alternative I for Sale 186 is zero.

Onshore pipeline spills on the North Slope and along the Trans-Alaska Pipeline System in winter would not be likely to affect fishes, because the likelihood of their contacting fish habitat is very low during that time. Small spills are likely to occur, but they are not likely to be of sufficient size or frequency to measurably affect fish populations. If a summer onshore spill of sufficient size occurred in a small waterbody that contained fish and had a restricted water exchange, the fish and food resources in that waterbody would be likely to be harmed or killed. Recovery would be likely in 5-10 years.

However, due to the small amount of oil likely to enter freshwater habitat, the low diversity and abundance of fish in most of the onshore area, and the unlikelihood of spills blocking fish migrations or occurring in overwintering areas or small waterbodies (containing many fish or fish eggs) with restricted water exchange, an onshore oil spill associated with Alternative I for Sale 186 is not likely to have a measurable effect on fish populations. For these reasons, while small numbers of fish in the immediate area of an onshore oil spill may be killed or harmed, onshore oil spills would not be likely to have a measurable cumulative effect on fish populations.

V.C.3.d(3) Tanker-Spill Effects

We estimate the cumulative number of tanker spills over the 15- to 20-year life of the project at 10 (Table V-12): 7 with an average size of 4,000 barrels, 2 with an average size of 13,000 barrels, and 1 with an average size of 250,000 barrels. None of these are likely to be contributed by Alternative I for Sale 186. Each of these oil spills is assumed to occur at different locations and to contact different resources. This precludes the same fish population from being affected by any two of these spills, and concerns pertaining to the time needed for the recovery of the affected fish populations. In the unlikely event of a large offshore oil spill contacting the nearshore area, some marine and migratory fish might be harmed or killed, as discussed in Section IV.C. However, it likely would not have a measurable effect on fish populations, and recovery would be likely within 10 years.

Future oil-spill effects from tanker transportation of arctic oil (including oil from Beaufort Sea Sales 195 and 202) from the Trans-Alaska Pipeline System terminal at Valdez could affect some marine and anadromous fishes in the Gulf of Alaska. Section IV.C.1.a discusses the likely effects of a large oil spill on individual fishes and fish populations, such as those associated with the 1989 *Exxon Valdez* oil tanker spill.

IV.C.3.e. Effects from the Annual Subsistence and Commercial Harvests

The subsistence harvesting of fishes in the Beaufort Sea area is discussed in the subsistence section of this EIS (Section IV.C.11). Relatively large numbers (estimated at 50,000-200,000) of freshwater and migratory fishes are harvested each year for subsistence and commercial purposes on the North Slope. These activities have a substantial and measurable effect on the freshwater and migratory fish populations of the North Slope. That effect and its relationship to natural fluctuations (often extreme) in North Slope fish populations, is the primary reason for the establishment of annual State of Alaska, Department of Fish and Game fishing quotas. However, to our knowledge no studies have been conducted addressing the cumulative effect of subsistence and commercial fishing on the North Slope fish populations, or on the amount of time required for recovery. Hence, the cumulative effect of these activities on the fish populations of the North Slope is unknown.

Summary. In general, marine and migratory fish populations are not measurably affected by the type of disturbances generated by oil- and gas-related activities. The wide distribution of and low density of fishes, the short-term and mild nature (local avoidance) of their response to noise associated with oil and gas activities, and the wide distribution and low density of likely oil and gas projects is the basis for this conclusion. Some overwintering fishes may not be able to avoid noise and disturbances, and may be adversely affected. However, this is not likely to occur often and most fishes would be unaffected. Because the water used for construction is not likely to be withdrawn from waters supporting fish, the use of freshwater for ice-road and pad construction is not likely to have a measurable cumulative effect on fish populations. Hence, disturbances associated with Alternative I for Sale 186 are not likely to contribute measurably to the overall cumulative effect on fishes.

According to Table V-12, the most likely number of oil spills (greater than 1,000 barrels) that would be contributed by Alternative I for Sale 186 is zero. Nevertheless, in the unlikely event of a large oil spill, small numbers of fish in the immediate area may be killed or harmed if they were somehow trapped and unable to avoid it. However, marine and migratory fishes are widely distributed in the Beaufort Sea, most are not likely to become trapped, and most are not likely to be affected by an oil spill. Those that are in the vicinity of a large oil spill and are affected by it are likely to experience effects ranging from minor and short-term to no effect at all. For these reasons, oil spills associated with Alternative I for Sale 186 are not likely to have a measurable additive effect or synergistic effect on fish populations.

Conclusion: Some fish in the vicinity of a large oil spill may be adversely affected by it. Those that are affected are likely to experience effects ranging from minor and short-term to no effect at all.

Contribution of Alternative I for Sale 186 to Cumulative Effects. Disturbances and oil spills associated with Alternative I for Sale 186 are not likely to make a measurable contribution to the overall cumulative effect on fishes. No synergistic effects are expected.

V.C.4. Essential Fish Habitat

Past development and production has occurred on 28 fields and satellites, including seven offshore. Present development includes four discoveries that are expected to begin production within the next few years. If 16 reasonably foreseeable future discoveries are developed within the next 15-20 years and 9 are located offshore, Alternative I for Sale 186 is estimated to contribute 7% of past present and reasonably foreseeable development to 2023.

The low level of effects from seismic surveys, exploration and drilling activities, and drilling mud are unlikely to increase above the present level of effects, because there is an extremely low chance of the same geographical area to be contacted twice without sufficient recovery time between spills.

Because we have been unable to document impacts or conclusively show the lack of impacts to anadromous species, including salmon, when removing up to 15% of free water from large lakes, we have to assume there is a potential for effects to these fish. The effects of ice-road construction on freshwater salmon essential fish habitat could range from low (a population change in abundance or distribution in a localized area for a short time) to moderate (a population change in abundance or distribution but recovery would occur within one generation). Therefore, if a substantial proportion of all past, present, and reasonably foreseeable future projects cause low to moderate effects, cumulative effects could conceivably range from low to moderate and even to high (a population change in abundance or distribution requiring one or two generations to recover to its former status).

The substantial accumulation of effects on essential fish habitat, however, is most likely to occur from a large oil spill. Marine waters have the greatest likelihood of being oiled, up to a 59% chance of being oiled within 10 days if a large oil spill occurs and a 65% chance within a year. However, because of the low water temperatures, the marine habitat is unlikely to support any salmon, even with a maximum trend of temperature increases each decade. Therefore, no cumulative effect of oil spills on marine essential fish habitat is likely, because the effects likely would dissipate before salmon ever use the habitat.

Because local residents do see increasing numbers of salmon and an average of two salmon per year are caught during scientific studies in the Beaufort Sea (see Section IV.C.4), there is actual estuary and salmon habitat in use, although it is not very large. If the 8-10% probability of a large oil spill actually occurring as a result of Alternative I for Sale 186, the greatest likelihood of oil reaching the coastal freshwater essential fish habitat is 3-14%. Because Alternative I for Sale 186 is expected to contribute 17% of offshore large oil spills and the effects of large oil spills are additive, the cumulative effects of 2.8 oil spills are approximately 6 times that of Alternative I for Sale 186.

Summary and Conclusion: The low level of effects from seismic surveys, exploration and drilling activities, and drilling mud are unlikely to increase above the present level of effects. The substantial accumulation of effects on essential fish habitat are more likely to occur from oil spills effects on freshwater and estuarine water than on marine water essential fish habitat. However, because of the low water temperatures, the marine habitat is unlikely to support any salmon, even with a maximum trend of temperature increases each decade. Therefore, no cumulative effect of oil spills on marine essential fish habitat is likely, because the effects likely would dissipate before salmon ever use the habitat. Cumulative effects on essential estuarine and freshwater fish habitat also are considered minimal, because the habitat is marginal. Salmon 'populations' using this freshwater or estuarine habitat have an extremely short theoretical time to extinction, i.e., possibly as short as one generation. If oil spills were to occur in an area where salmon successfully spawned, they could further decrease the already marginal chances of another generation successfully reproducing.

Contribution of Alternative I for Sale 186 to Cumulative Effects. The contribution of Alternative I, Sale 186 to the cumulative effect level of seismic surveys, exploratory drilling, and drilling mud are unlikely to increase above the present low level of effects. If a large oil spill actually occurs as a result of Alternative I for Sale 186, the greatest likelihood of oil reaching the coastal freshwater essential fish habitat is 3-14%. No synergistic effects are expected.

V.C.5. Threatened and Endangered Species

V.C.5.a. Bowhead Whale

V.C.5.a(1) Cumulative Effects on Bowhead Whales

V.C.5.a.(1)(a) Projects That May Affect Bowhead Whales

There are several projects that might affect bowhead whales. Endicott and Northstar are past development projects currently producing oil. The Liberty Project is a reasonably foreseeable future development project that is located shoreward of the barrier islands and well shoreward of the bowhead whale's normal fall-migration route. An exploration plan for the McCovey Prospect has been approved northwest of Cross Island; if this results in submittal of a future development and production plan, coordination with Native groups will be necessary to maintain traditional hunting in the area. The Kuvlum and Hammerhead units, both reasonably foreseeable future development projects, are within the bowhead whale's normal fall-migration route. The Sandpiper and Flaxman Island units, also reasonably foreseeable future development projects, are not within the bowhead whale's normal fall-migration route. Endicott, Northstar, and Flaxman Island are all or mostly on State lands. These projects and their potential effects on whales are discussed later. Other Federal and State sales in the Beaufort Sea that are scheduled through 2007 could lead to more noise and disturbance from exploratory activities. Other types of projects mentioned above likely would not affect whales. These include the Trans-Alaska Pipeline System; constructing the Trans-Alaska Gas System, the Alaska Natural Gas Transportation System; converting natural gas to liquefied natural gas; or tankering crude oil from Valdez.

The potential for oil-industry activities outside of the Alaskan Beaufort Sea appears to be limited. Two Federal lease sales were conducted in the Chukchi Sea and exploration activities were conducted, but no producible wells were discovered. A Chukchi Sea/Hope Basin lease sale scheduled in the 1997-2002 OCS oil and gas leasing program was deferred. Two Chukchi Sea/Hope Basin lease sales are scheduled in the 2002-2007 OCS oil and gas leasing program. The Chukchi Sea will likely proceed through a "special interest" process, a new process for leasing Federal tracts. It is somewhat speculative whether industry interest in the area is sufficient that sales will be held in the future. Although there are no plans for future oil and gas exploration activities in the Bering Sea south of St. Lawrence Island, a "special interest" offering in Norton Sound in the northern Bering Sea was just completed on April 22, 2002. No nominations were received during the "special interest" offering. Although the entire Norton Sound area was open for nomination, the purpose of the "special interest" process is to identify and offer only small, focused areas where industry has a significant interest in exploration. In the Canadian Beaufort Sea, the main area of industry interest has been around the Mackenzie River Delta and offshore of the Tuktoyaktuk Peninsula. Oil was discovered in these areas, although industry showed little interest in the area during the 1990's. Interest in the area increased recently, and an open-water seismic-exploration program was conducted off the Mackenzie River Delta during late summer and autumn of 2001. This was the first major offshore seismic program in that area since the early 1990's. We are not aware of plans for any additional seismic surveys. Some drilling operations may be conducted over the next few years.

V.C.5.a(1)(b) Effects of These Projects on Bowhead Whales

Some effects on bowhead whales may occur because of activities from previous and proposed lease sales of State and Federal areas offshore. Generally, bowhead whales remain far enough offshore to be mainly in Federal waters, but they move into State waters in some areas, such as the Beaufort Sea southeast and north of Kaktovik and near Point Barrow. We detailed these potential effects in the Beaufort Sea Sale 170 final EIS (USDOI, MMS, 1998).

To date, activities conducted in State waters or on the OCS in the Beaufort Sea as a result of previous Federal lease sales since 1979 apparently have not had adverse effects on the bowhead whale population. Although numerous exploration wells have been drilled in the Beaufort Sea from a variety of platforms, including gravel islands, ice islands, bottom-founded drilling platforms, submersibles, and drillships and extensive seismic surveys have been conducted, no bowhead whale mortality has been reported. The bowhead whale population has continued to increase over that timeframe. However, Inupiat whalers have stated that noise from these activities at least temporarily displaces whales farther offshore, especially if the operations are conducted in the main migration corridor. Whales may avoid areas where seismic surveys or drilling operations are being conducted. Recent monitoring studies (Miller et al., 1997, 1999; Miller, Elliot, and Richardson, 1998) indicate that most whales migrating in the fall avoid an area with a radius about 20-30 kilometers around a seismic vessel operating in nearshore waters. These studies are discussed in detail below.

In general, development projects such as Endicott or Northstar, and reasonably foreseeable future development projects such as Liberty, are not likely to harm bowhead whales. Endicott is inside the barrier islands in relatively shallow water. Support traffic travels over the causeway. Although Northstar is not inside the barrier islands, it is well shoreward of the bowhead's fall-migration route. Operations for both Endicott and Northstar projects are conducted from gravel structures, which limit how far noise would travel. The Liberty Project is located inside of the barrier islands, well shoreward of the bowhead's fall-migration route (USDOI, MMS, Alaska OCS Region, 2002a). Operations for the Liberty Project, if developed, also likely would be conducted from gravel structures, limiting how far noise would travel. Studies discussed in Section IV.C.5 indicate that noise from oil and gas operations on gravel islands is substantially attenuated within 4 kilometers and not detectable at 9.3 kilometers.

Some bowhead whales could be disturbed if development proceeds at the Kuvlum and Hammerhead units or other reasonably foreseeable future development projects, such as the Sandpiper or Flaxman Island units. The Kuvlum and Hammerhead units are within the bowhead whale's normal fall-migration route. Development of these units likely would share infrastructure with the Badami group. Each unit likely would have its own production pads and wells and a pipeline connecting it to an existing or planned field associated with Badami. Installing production platforms and constructing pipelines could disturb some bowhead whales on their fall migration, if pipeline construction in deeper water took place during the latter part of the open-water season. If helicopters from Deadhorse pass low overhead, they could cause bowheads to dive. Whales would try to avoid close approach by vessels.

The Sandpiper and Flaxman Island units are not within the main bowhead whale fall migration route. Sandpiper is near Northstar, and the effects on bowheads from development at that location likely would be similar to those expected from Northstar. Flaxman Island is closer to the bowhead whale's main fall-migration route, but it is a barrier island. In general, noise from oil and gas activities on gravel islands does not travel more than a few kilometers. Development of the Sandpiper unit likely will share infrastructure with the Northstar group. The unit likely would have its own production pads and wells and a pipeline connecting it to Northstar. Development of the Flaxman Island unit likely would share infrastructure with the Badami group. The unit likely would have its own production pads and wells and a pipeline connecting it to a past or present development project associated with Badami.

In the Canadian Beaufort Sea, the main area of industry interest has been around the Mackenzie River Delta and offshore of the Tuktoyaktuk Peninsula. Bowhead whales summering in this area are thought to spend much of their time feeding. Industry interest in the area increased recently and an open-water seismic-exploration program was conducted off the Mackenzie River Delta during late summer and autumn of 2001. This was the first major offshore seismic program in that area since the early 1990's. We are not aware of plans for any additional seismic surveys.

V.C.5.a(1)(c) Effects of Noise, Oil Spills, and other Contaminants on Bowhead Whales

Overall, cumulative effects to bowhead whales could include behavioral responses to seismic surveys; aircraft and vessel traffic; exploratory drilling; construction activities, including dredging/trenching and pipelaying; and development drilling, production operations, and oil-spill-cleanup operations that take place at varying distances from the whales. In general, bowheads may try to avoid vessels or seismic surveys if closely approached, but they do not respond much to aircraft flying overhead at 1,000 feet or more. Bowheads also try to avoid close approaches by motorized hunting boats. Bowhead whales whose behavior appeared normal have been observed on several occasions within 10-20 kilometers of drillships in the eastern Beaufort Sea, and there have been a number of reports of sightings within 0.2-5 kilometers from drillships (Richardson et al., 1985; Richardson and Malme, 1993). On several occasions, whales were well within the zone where they should have been able to detect the noise. However, some bowheads are likely to change their migration speed and swimming direction to avoid getting close to them. Whales appear less concerned with stationary sources of relatively constant noise than with moving sources. Bowheads do not seem to travel more than a few kilometers in response to a single disturbance, and behavioral changes are temporary, lasting from minutes (for vessels and aircraft) up to 30-60 minutes (for seismic activity). Detailed discussions of how these various activities may affect bowheads can be found in the Final EIS's for Beaufort Sea Lease Sales 144 and 170, the Final EIS for the Liberty Development and Production Plan, and the Section 7 consultation for the Beaufort Sea Region (USDOI, MMS, 1996a, 1998; USDOI, MMS, Alaska OCS Region, 2002a; National Marine Fisheries Service, 2001). There has been some new information on the effects of seismic on bowhead whales from recent seismic studies. Information from studies conducted during the 1980's and new information from studies conducted during the 1990's are presented in the following.

Studies were conducted on the reactions of bowhead whales to marine seismic operations in the Canadian and Alaskan Beaufort Sea during the summer and early autumn in the early to mid 1980's. Detailed monitoring of the reactions of migrating bowheads to nearshore seismic operations was conducted from 1996-1998. The results of these two projects were different (LGL Ltd., 2001). Differences also were noted in the seismic operations conducted during the two timeframes. Seismic surveys in the 1980's were 2-dimensional surveys with wider spacing between gridlines, and they generally were conducted in deeper waters using larger arrays. Surveys from 1996-1998 were 3-dimensional surveys with gridlines much closer together, and the surveys were conducted in shallow waters much closer to shore using smaller arrays.

During the 1980's, the behavior of bowhead whales exposed to noise pulses from seismic surveys was observed during the summer in the Canadian Beaufort Sea and during the fall migration across the Alaskan Beaufort Sea (Reeves et al., 1984; Fraker et al., 1985; Richardson et al., 1986, as referenced in LGL Ltd., 2001). There also were a number of partially controlled experiments to observe the reactions of bowhead whales to single airguns and to full-scale arrays. These studies showed that most bowheads exhibited strong avoidance behavior and changes in surfacing, respiration, and dive cycles when an operating seismic vessel approached within a few kilometers. During the studies in the 1980's, bowheads exposed to pulses from vessels more than 7.5 kilometers away rarely showed observable avoidance of the vessel, but their surface, respiration, and dive cycles appeared to be altered in a manner similar to that observed in whales exposed at a closer distance (LGL Ltd., 2001). Ljungblad et al. (1985, 1988) conducted a series of four experimental tests of bowhead reactions to seismic surveys in the western Beaufort Sea during the early fall. Total avoidance, with all whales moving away from the source, occurred at 3, 3.5, and 7.2 kilometers from the three vessels using arrays of airguns, and at 1.25 kilometers from the vessel using a single airgun. Whales also demonstrated reduced surfacing and dive duration, fewer blows per surfacing, and longer intervals between successive blows. Observers noted that some whales were displaced by several kilometers, and that changes in behavior lasted for up to an hour (LGL Ltd., 2001). A more detailed discussion of the potential for noise disturbance to bowheads from seismic activities and a discussion about some of the limitations of the Ljungblad et al. (1985) study can be found in the Beaufort Sea Planning Area Oil and Gas Lease Sale 170 final EIS and the Section 7 consultation for the Beaufort Sea Region (USDOI, MMS, 1998; National Marine Fisheries Service, 2001, respectively). Various limitations to these studies also were pointed out by Dr. Tom Albert, North Slope Borough during the Arctic Seismic Synthesis and Mitigating Measures Workshop (USDOI, MMS, Alaska OCS Region, 1997).

Richardson et al. (1986) observed whales near another full-scale vessel with a 2,870-cubic-inch airgun array. Whales exposed to sounds from this array began to orient away from the vessel at 7.5 kilometers, but some continued to feed in the area until the vessel was within 3 kilometers. The whales were displaced approximately 2 kilometers, and behavioral changes were noted to persist for at least 2.4 hours.

It is likely that some migrating bowheads avoid seismic operations at distances exceeding those in the studies discussed above. One apparent longer distance response involved bowheads swimming away from a seismic vessel 24 kilometers away (LGL Ltd., 2001). Subtle changes in surfacing, respiration, and dive cycles, detected only by statistical analysis, were noted at longer distances, out to at least 73 kilometers (LGL Ltd., 2001).

New information on the effects of seismic noise on bowheads is now available from marine mammal monitoring programs conducted in 1996-1998 (Miller et al., 1997, 1999; Miller, Elliot, and Richardson, 1998). The LGL and Greeneridge 1996-1998 monitoring studies were analyzed to determine the general position of the bowhead migration corridor at times with and without seismic activity. The results revealed no clear effect of the 1996 and 1997 seismic programs on the position of the general migration corridor in the central Alaskan Beaufort Sea. In 1996, Miller et al. (1997) found nearly all the bowhead whales in relatively nearshore waters, mainly between the 15-meter- and 40-meter-depth contours, about 10-50 kilometers from shore. Overall, bowhead sightings were fairly broadly distributed between the 10-meter- and 50-meter-depth contours (Miller et al., 1999). However, the analyses were limited by the low number of sightings potentially influenced by seismic activities. In 1997, nearly all bowhead sightings were in relatively nearshore waters, between the 10-meter- and 40-meter-depth contours, unusually close to shore (Miller et al., 1999). Many aggregations of feeding whales were observed near or just shoreward of the 10-meter depth contour. In 1998, the bowhead migration corridor generally was farther offshore than in either 1996 or 1997, between the 10-meter- and 100-meter-depth contours and approximately 10-60 kilometers from shore (Miller et al., 1999). The distributions of sightings during periods with and without seismic exploration broadly overlapped. The 1996-1998 combined data indicated that sighting distributions tended to be farther offshore during times of seismic operations than with no seismic operations.

During 1996-1998 combined survey efforts, sighting distributions tended to be farther offshore on days with seismic airguns operating compared to days without seismic airguns operating. This was true for the study area as a whole, for the East region, and marginally so for the West region. The difference in the Central region was not statistically significant.

Aerial survey results indicated that bowheads tended to avoid the area around the operating source to a radius of about 20 kilometers. Results of the 1996-1998 studies show that bowheads rarely were seen within 20 kilometers of the operations area at times when airguns were operating, but there were some sightings within 20-30 kilometers of the nearest shotpoint (Miller et al., 1999). Sighting rates within a radius of 20 kilometers of seismic operations were significantly lower during seismic operations than when no seismic operations were occurring. Within 12-24 hours after seismic operations ended, the sighting rate within 20 kilometers was similar to the sighting rate beyond 20 kilometers. There was little or no evidence of differences in headings, general activities, and swimming speeds of bowheads with and without seismic operations. Miller et al. (1999) stated that the lack of any statistically significant difference in headings should be interpreted cautiously. Because it has been shown that most bowheads within 20 or even 30 kilometers of the operating airgun array showed avoidance or deflected offshore, westbound bowheads must have turned to the right at some point as they approached the seismic operation. Miller et al. (1999) noted that the distance at which deflection began cannot be determined precisely, but they stated that considering times with operations on offshore patches, deflection may have begun about 35 kilometers to the east. However, some bowheads approached within 19-21 kilometers of the airguns when they were operating on the offshore patches. It appears that in 1998, the offshore deflection might have persisted for at least 40-50 kilometers west of the area of seismic operations. In contrast, during 1996-1997 there were several sightings in areas 25-40 kilometers west of the most recent shotpoint, indicating the deflection in 1996-1997 may not have persisted as far to the west.

The observed 20- to 30-kilometer (12.5-18.8 mile) area of avoidance is a larger avoidance radius than was evident from scientific studies in the 1980's (approximately 7.5 kilometers). However, it is less than the 48 kilometers (30 miles) suggested by subsistence whalers, based on their experience with the types of seismic operations that occurred in the Beaufort Sea before 1996 (Richardson, 2000). Regarding the studies conducted in the 1980's, Richardson and Malme (1993) noted that strong avoidance may occur infrequently at distances of 20 kilometers or more (Koski and Johnson, 1987), although active avoidance usually does not begin unless the seismic ship is closer than 8 kilometers. Richardson and Malme (1993) noted that the apparent avoidance response observed by Koski and Johnson was the longest distance of a seismic vessel documented in the studies they reviewed. Regarding the distance suggested by subsistence whalers, whaling captains from Barrow, Nuiqsut, and Kaktovik, in written testimony at the Arctic Seismic Synthesis and Mitigating Measures Workshop on March 5-6, 1997 (USDOI, MMS, Alaska OCS Region, 1997), in Barrow, Alaska, stated:

> Factual experience of subsistence whalers testify that pods of migrating bowhead whales will begin to divert from their migratory path at distances of 35 miles from an active seismic operation and are displaced from their normal migratory path by as much as 30 miles.

During the 1996-1998 bowhead hunting seasons, seismic operations were moved to locations well west of Cross Island, the area where Nuiqsut-based whalers hunt for bowheads (Miller et al., 1999). This was done under the provisions of the Conflict Avoidance Agreements established between industry and the hunters in 1996-1998. No perceived interference between seismic operations and hunting was reported either in 1998 or in 1996-1997. As a result of mitigation measures implemented under the 1996-1998 Conflict Avoidance Agreements, the 1996-1998 seismic surveys did not adversely affect the accessibility of bowheads to subsistence whalers (Miller et al., 1999).

With respect to these studies conducted in the Beaufort Sea from 1996-1998, the peer review group at the Arctic Open-Water Noise Peer Review Workshop in Seattle from June 5-6, 2001, prepared a summary statement supporting the methods and results reported in Richardson et al. (1999) concerning avoidance of seismic sounds by bowhead whales:

> Monitoring studies of 3-D seismic exploration (8-16 airguns totaling 560-1,500 cubic inches) in the nearshore Beaufort Sea during 1996-1998 have demonstrated that nearly all bowhead whales will avoid an area within 20 km of an active seismic source, while deflection may begin at distances up to 35 km. Sound levels received by bowhead whales at 20 km ranged from 117-135 dB re 1μPa rms and 107-126 dB re 1μPa rms at 30 km. The received sound levels at 20-30 km are considerably lower levels than have previously been shown to elicit avoidance in bowhead or other baleen whales exposed to seismic pulses.

Behavioral studies suggested that some bowhead whales may get used to noise from distant ongoing drilling, dredging, or seismic operations, but they still will exhibit some localized avoidance (Richardson and Malme, 1993). Bowhead whales have behaved normally while on their summer feeding grounds within a few kilometers of operating drillships, well within the zone where drillship noise is clearly detectable (Richardson, Wursig, and Greene, 1990; Richardson, Wells, and Wursig, 1985; Richardson and Malme, 1993). Some bowhead whales tolerate considerable underwater noise from actual drillships and dredges. Biologists saw bowheads as close as 4 kilometers from a drillship, 10 kilometers from a conical drilling unit, and 0.8 kilometer from a suction dredge. Richardson, Wursig, and Greene also observed behavioral reactions of bowhead whales to underwater playbacks of recorded drillship and dredge noise. Some (but not all) bowheads oriented away when received noise levels and spectral characteristics were comparable to those several kilometers from actual drillships and dredges. During some playback tests call rates decreased; feeding ceased; and cycles of surfacing, respiration, and diving may have changed. The sensitivity of various whales differed. Roughly half responded when the received level of noise was about 115 dB re 1μPa on a broadband basis, or about 110 decibels in one 1/3-octave band at 0-30 decibels above ambient). These levels occurred about 3-11 kilometers from a drillship and dredge. The study concluded that some bowheads might habituate to prolonged noise exposure. Alternatively, only the less sensitive individual whales may be found within 5 kilometers of drillships and dredges. We do not have enough evidence to know whether or not industrial activity continuing for several years would preclude bowheads from using an area; and no documented evidence shows that noise from outer continental shelf operations would act as a barrier to migration.

Inupiat whalers observed and reported that noise from some drilling activities, especially drilling from drillships with icebreaker support in the main migration corridor, displaces whales farther offshore away from their traditional hunting areas. Inupiat whalers also have observed and reported that noise from seismic activities displaces whales farther offshore.

Overall, exposure to noise from oil and gas operations should not kill any bowhead whales, but some could experience temporary, nonlethal effects. There is no clear indication that disturbance from oil and gas exploration and development activities since the mid-1970's has had an additive or synergistic effect on the bowhead whale population. That population has been steadily increasing at the same time that oil and gas activities have been occurring in the Beaufort Sea and throughout the bowhead whale's range. Major changes in the bowhead's migration route through the Beaufort Sea are unlikely to result from this noise, although some individuals may be diverted farther offshore.

A more detailed discussion of the potential for noise disturbance to bowheads from industry activities, particularly drillship and seismic, can be found in the Beaufort Sea Planning Area Oil and Gas Lease Sale 170 final EIS and the Section 7 consultation for the Beaufort Sea Region (USDOI, MMS, 1998; National Marine Fisheries Service, 2001, respectively).

Bowhead whales could be affected by oil spills from oil and gas projects in the Beaufort Sea. Beaufort Sea Sale 186 represents about 7.66% of past and present oil and gas development projects in the Beaufort Sea area and about 3.80% of past, present, and reasonably foreseeable future oil and gas development projects in the Beaufort Sea area (Table V-7b). It is expected to contribute about 17% of the mean number of spills on the offshore area (Table V-13). The total estimated mean number of cumulative offshore spills is 0.65, and the estimated mean number of spills from the Beaufort Sea Sale 186 is 0.11. The most likely number of offshore spills for the Beaufort Sea Sale 186 is zero (Table V-13). It is expected to contribute about 4% of mean number of spills for the Trans-Alaska Pipeline System tanker spills (Table V-13). Because more oil spills are likely to occur under the cumulative case than for Beaufort Sea Sale 186 alone, whales are more likely to contact spilled oil, and oil-spill effects may be greater. However, oil has more of a chance of contacting the bowhead's habitat than the whales themselves.

The effects of oil on bowhead whales would be essentially as described in Section IV.C.5. Individuals exposed to spilled oil may inhale hydrocarbon vapors, experience some damage to skin or sensory organs, ingest spilled oil or oil-contaminated prey, feed less efficiently because of baleen fouling, and lose some prey killed by the spill. Prolonged exposure to freshly spilled oil could kill or injure a few whales.

Geraci (1990) reviewed a number of studies on the physiologic and toxic effects of oil on whales and concluded there was no evidence that oil contamination had been responsible for the death of a cetacean. Nevertheless, the effects of oil exposure to the bowhead whale population are uncertain, speculative, and controversial. The effects would depend on how many whales contacted oil, the duration of contact, and the age/degree of weathering of the spilled oil. The number of whales contacting spilled oil would depend on the size, timing, and duration of the spill; how many whales were near the spill; and the whales' ability or inclination to avoid contact. If oil got into leads or ice-free areas frequented by migrating bowheads, a large portion of the population could be exposed to spilled oil. Prolonged exposure to freshly spilled oil could kill some whales, but the number likely would be small. More information on the effects of noise and oil spills on bowhead whales can be found in Section IV.C.5.

Some information is available regarding how heavy metals and other contaminants may affect bowhead whales. Heavy metals and other contaminants, while not specifically associated with oil spills, are of concern to the health of bowhead whales and to humans who use bowhead whales for food. Information about cetacean metabolism also is inadequate. Bratton et al. (1993) measured organic arsenic in the liver tissue of one bowhead whale and found that about 98% of the total arsenic was arsenobetaine. Arsenic in marine biota generally is in an organic form, mostly arsenobetaine, that appears to be nontoxic and of no concern to humans using them as food. Based on the limited data available, researchers (Bratton et al., 1993) concluded that petroleum products appear not to harm bowheads or humans who eat them, but we need more research to be certain. In addition, we provided funds to the National Oceanic and Atmospheric Administration in 1987 to establish and conduct a program for collection and long-term storage of tissues from Alaska marine mammals for future contaminant analysis. This program, the Alaska Marine Mammal Tissue Archival Project, which has been managed by the National Marine Fisheries Service since 1992, contains tissue samples from bowhead whales and other marine mammals. Tissue samples were collected from whales landed at Barrow in 1992. Initial studies of bowhead tissues (Becker et al., 1995) indicate that bowhead whales have very low levels of mercury, PCB's, and chlorinated hydrocarbons, but they have fairly high concentrations of cadmium in their liver and kidneys. Cadmium is a naturally occurring heavy metal that commonly is present at high levels in marine mammal tissues, particularly in the liver and kidney. The study concluded that the high concentration of cadmium in the liver and kidney tissues of bowheads warrants further investigation. Becker (2000) noted that concentration levels of chlorinated hydrocarbons in bowhead whale blubber generally are an order of magnitude less than what has been reported for beluga whales in the Arctic. This probably reflects the difference in the trophic levels of these two species; the bowhead is a baleen whale that feeds on copepods and euphausiids, while the beluga whale is a toothed whale that feeds at a level higher in the food web. The concentration of total mercury in the liver also is much higher in beluga whales than in bowhead whales.

Bratton et al. (1997) looked at eight metals (arsenic, cadmium, copper, iron, mercury, lead, selenium, and zinc) in the kidneys, liver, muscle, blubber, and visceral fat from bowheads harvested from 1983-1990. These metals were chosen because they are the most common metals reported in the literature for cetaceans, they represent the most toxic metals to marine organisms, and they are the most likely metals to enter the Inupiat diet. They observed considerable variation in tissue metal concentration among the whales tested. Metal concentrations evaluated did not appear to increase over time between 1983 and 1990. Based on metal levels reported in the literature for other baleen whales, the metal levels observed in all tissues of the bowhead are similar to levels in other baleen whales. None of the metals studied were high enough in muscle, blubber, or visceral fat to pose a risk to human consumers. The study concluded the tissues from bowhead whales are, in general, nutritious and safe to eat. The bowhead whale has little metal contamination as compared to other arctic marine mammals, except for cadmium, which requires further investigation as to its role in human and bowhead whale health. The study recommended limiting the consumption of kidney from large bowhead whales pending further evaluation.

Conclusion: Exposure of bowhead whales to noise from oil and gas operations is not likely to kill any bowhead whales, but some could experience temporary, nonlethal effects. Whales exposed to spilled oil likely would experience temporary, nonlethal effects, although prolonged exposure to freshly spilled oil could kill some whales. The levels of metals and other contaminants measured in bowhead whales appear to be relatively low.

V.C.5.a(1)(d) Effects of Other Activities on Bowhead Whales

Activities that are not oil and gas related also affect bowhead whales. Incidental take of bowhead whales apparently is rare. Between 1976 and 1992, only three ship-strike injuries were documented out of a total of 236 bowhead whales examined from the Alaskan subsistence harvest (George et al., 1994). The low number of observations of ship-strike injuries suggests that bowheads either do not often encounter vessels or they avoid interactions with vessels, or that interactions usually result in the animals' death. The bowhead whales' association with sea ice limits the amount of fisheries activity occurring in bowhead habitat. A young bowhead was reported to have died after being entrapped in fishing net in Japan (Shelden and Rugh, 1995) and another in northwest Greenland in a net used to capture beluga whales. Several cases of rope or net entanglement, at least 10 incidents from 1978-1999, have been reported from whales taken in the subsistence hunt (Angliss, DeMaster, and Lopez, 2001). The number of entanglements or scarring attributed to ropes may include more than 20 cases (Craig George, as cited in Angliss and Lodge, 2002 draft). There are no observer program records of bowhead whale mortality incidental to commercial fisheries in Alaska. New information on entanglements of bowhead whales indicates that bowheads do have interactions with crab-pot gear. There have been two confirmed occurrences of entanglement in crab-pot gear, one in 1993 and one in 1999 (Angliss and Lodge, 2002). Based on currently available data, the estimated annual mortality rate incidental to commercial fisheries is 0.2 (Angliss and Lodge, 2002).

Subsistence whaling authorized by the International Whaling Commission is another activity on the outer continental shelf that affects the bowhead whale. Bowheads are harvested by Alaska Natives in the northern Bering Sea and in the Chukchi Sea on their spring migration and in the Beaufort Sea on their fall migration. Canadian and Russian Natives also have requested to harvest bowhead whales. The Canadian Government granted permission in 1991 to kill one bowhead, and a bowhead was harvested in Mackenzie Bay in fall 1991. Additional permits were granted in 1993 and 1994, but no bowheads were harvested in either year. There is renewed interest by villages along the Russian Chukchi Sea coast to hunt bowhead whales. At the 1997 International Whaling Commission, the Commission approved a combined quota allowing an average of 56 bowheads to be landed each year to meet the needs of Eskimos in Alaska and Russia.

Since subsistence whaling was authorized by the International Whaling Commission in 1977, the number of whales harvested has ranged between 14-72 per year, depending in part on changes in management strategy and in part on higher estimates of bowhead whale abundance in recent years. The total estimated take annually by Alaska Natives in recent years, including struck and lost whales, was reported to be 41 (1990), 46 (1991), 46 (1992), 51 (1993), 46 (1994), 57 (1995), 44 (1996) (Hill and DeMaster, 1999), 66 (1997), 54 (1998), 47 (1999) (Angliss, DeMaster, and Lopez, 2001), 47 (2000), and 75 (2001) (Anliss and Lodge, 2002). Hunters from the western Canadian Arctic community of Aklavik killed one whale in 1991 and one in 1996. The average annual subsistence take (by Natives of Alaska and Canada) during the 5-year period from 1995 to 1999 is 54 bowhead whales (Angliss, DeMaster, and Lopez, 2001). The average annual subsistence take during the 5-year period from 1997-2001 is 58 bowhead whales (Angliss and Lodge, 2002).

Subsistence whaling quotas change every few years. A quota of 266 strikes or 204 bowhead whales landed was authorized by the International Whaling Commission for 1995-1997 to be divided among 10 Alaskan villages (Shelden and Rugh, 1995). There is a 5-year block quota of 280 bowhead whales landed, authorized by the International Whaling Commission for 1998-2002 (64 *FR* 28413). The number of bowheads struck in each year may not exceed 67, except that any unused portion of a strike quota from any year may be carried forward; however, no more than 15 strikes may be added to the strike quota for any one year. There were 15 unused strikes available after the 1997 harvest, and the combined strike quota for 1998 was 82 (67 + 15). There were 15 unused strikes available after the 1998 harvest, and the combined strike quota for 1999 was 82 (67 + 15). The Eskimos in Alaska and the Chukotka Natives in the Russian Far East shared the 82 combined strike quota for 1998 and 1999. In 1999, the Chukotka Natives in the Russian Far East were allowed no more than 7 strikes, and the Alaska Eskimos were allowed no more than 75 strikes. The quota for Alaska Eskimos is divided among 10 Alaskan villages in the Bering, Chukchi, and Beaufort seas. This compares with the previous quota of 266 strikes, or 204 bowhead whales landed, authorized by the International Whaling Commission for 1995-1998 to be divided among 10 Alaskan villages (Shelden and Rugh, 1995). This level of harvest was approved by the International Whaling Commission under the supposition that it still would allow for continued growth in the bowhead population. It is likely that the bowhead whale population will continue to be monitored and that the harvest quota will be set accordingly to maintain a healthy bowhead population level.

V.C.5.a(2) Transportation Effects on Bowhead Whales

Bowhead whales are a marine species that winter in the Bering Sea and migrate through the Chukchi Sea into the Beaufort Sea every spring. In the fall, they migrate back through the Chukchi Sea into the Bering Sea. Bowhead whales and their habitat are far removed from the tanker routes to the Far East and to southern California. Therefore, they would not be affected by overland transportation of oil through the Trans-Alaska Pipeline System or by marine transportation along the tanker routes.

Summary and Conclusions for Beaufort Sea, North Slope, and Transportation Activities on the Bowhead Whale. Bowhead whales might experience cumulative effects from OCS activities, such as oil spills or noise from drilling, vessel and aircraft traffic, construction, seismic surveys, or oil-spill-cleanup activities, and from non-OCS activities. Bowhead whales temporarily may move to avoid noise-producing activities and may experience temporary, nonlethal effects, if oil spills occur during activities associated with any past, present, or reasonably foreseeable future development projects in the arctic region.

We do not expect bowhead whales to die from noise produced while exploring, developing, and producing offshore oil and gas, but some whales could experience temporary, nonlethal effects. Some bowheads temporarily may move to avoid vessels and activities conducted for seismic surveys, drilling, and construction. Contact with spilled oil in the Beaufort Sea could cause some temporary, nonlethal effects to some bowhead whales, and a few could die from prolonged exposure to freshly spilled oil. There is no clear indication that disturbance from oil and gas exploration and development activities since the mid-1970's has had an additive or synergistic effect on the bowhead whale population. The bowhead whale population has been steadily increasing at the same time that oil and gas activities have been occurring in the Beaufort Sea and throughout the bowhead whale's range. Bowhead whales should not be affected by oil spills or activities associated with the transport of oil through the Trans-Alaska Pipeline System or by marine transportation along the tanker routes to market.

Activities that are not related to oil and gas also could have cumulative effects on bowhead whales. A small number of whales may be injured or killed as a result of entrapment in fishing nets or collisions with ships. Native whalers from Alaska harvest bowheads for subsistence and cultural purposes under a quota authorized by the International Whaling Commission. Native whalers from Russia also are authorized to harvest bowhead whales under a quota authorized by the International Whaling Commission.

Conclusion: Overall, exposure of bowhead whales to noise from oil and gas operations is not expected to kill any bowhead whales, but some could experience temporary, nonlethal effects. Whales exposed to spilled oil likely would experience temporary, nonlethal effects, although prolonged exposure to freshly spilled oil could kill some whales. The incremental contribution of effects from Beaufort Sea Sale 186 to the overall effects under the cumulative case is not likely to cause an adverse effect on the bowhead whale population.

Contribution of Beaufort Sea Sale 186 to Cumulative Effects: Noise contribution to cumulative effects from Alternative I for Sale 186 likely would be limited to temporary avoidance behavior by a few bowhead whales in response to aircraft and vessel traffic, drilling activities and possibly some seismic surveys.

Alternative I for Sale 186 represents about 7.66% of past and present oil and gas development projects in the Beaufort Sea area and about 3.80% of past, present, and reasonably foreseeable future oil and gas development projects in the Beaufort Sea area (Table V-7b). It is expected to contribute about 17% of the mean number of spills on the offshore area (Table V-13). The total estimated mean number of cumulative offshore spills is 0.65, and the estimated mean number of spills from the Beaufort Sea Sale 186 is 0.11. The most likely number of offshore spills for Alternative I for Sale 186 is zero (Table V-13). It is expected to contribute about 4% of mean number of spills for the Trans-Alaska Pipeline System tanker spills (Table V-13). Because more oil spills are likely to occur under the cumulative case than for Alternative I for Sale 186 alone, whales are more likely to contact spilled oil, and oil-spill effects may be greater. Some individuals exposed to spilled oil may inhale hydrocarbon vapors, experience some damage to skin or sensory organs, ingest spilled oil or oil-contaminated prey, feed less efficiently because of baleen fouling, and lose some prey killed by the spill. Prolonged exposure to freshly spilled oil could kill or injure a few whales.

V.C.5.b. Spectacled and Steller's Eiders

V.C.5.b(1) Cumulative Effects on Spectacled and Steller's Eiders

V.C.5.b(1)(a) Projects and Activities That Could Contribute to Cumulative Effects

In addition to development of the prospects associated with Alternative I for Sale 186, other Federal and State projects and associated activities that could contribute to cumulative effects on migratory eiders seasonally occupying the Arctic Coastal Plain are outlined in Section V.C. Other projects and activities occurring on the Arctic Coastal Plain, along migration routes, or on the winter range also could contribute to cumulative effects. These include subsistence harvests, commercial fishing, environmental contamination including oil spills (large oil spill is an unlikely event), marine shipping, and recreational activities. These projects and activities could result in (1) additional oil or other toxic pollution effects (see the discussion in Section IV.C.5.b(1)), (2) additional disturbance during breeding and postbreeding periods, and (3) habitat degradation beyond what already has occurred in the Prudhoe Bay region.

V.C.5.b(1)(b) Disturbance

V.C.5.b(1)(b)1) Aircraft and Vessel Disturbance

Relatively large numbers of helicopter trips and substantial vessel traffic would be required to support offshore developments. Roadless development such as Alpine, Badami, and that projected for the National Petroleum Reserve-Alaska also may require substantial air support for development, although most construction would be done during winter. The number of helicopter roundtrips (Table IV.A-4) required to support exploration (155/year), construction (1-2 years, 300-600/month), development (28-56/month), and production (12-28/month) for Sales 186 and 195 have the potential for some overlap and, thus, higher totals would cause substantial increases in air traffic, amounting to perhaps 30-40 round trips per day.

Regardless of any attempts to mitigate effects by adjusting routes, continued activity at this level to support developing fields and future development is likely to result in some low-altitude flights over nesting, broodrearing, staging, or migrating spectacled eiders. Such disturbance is expected to result in short-term excess energy use by disturbed individuals and displacement of birds from the vicinity of routinely used air corridors. The latter would be similar to bird responses observed during low-level aerial bird-survey overflights where individuals dive, run across the water surface at various trajectories, or take flight, depending on species and circumstances. Such disturbance may flush females from nests resulting in lower productivity if eggs are lost to predators or exposure to low temperatures, or may cause displacement of females with broods from preferred foraging areas during broodrearing, or any individuals during preparation for migration.

If aircraft frequently overfly open water off river deltas in spring, some eiders may be displaced from this habitat. Because limited open water is available in spring, access to such areas is likely to be more restricted than in the postbreeding period. This could increase competition for the food available during this energetically stressful period following spring migration and could result in decreased survival or breeding success. In certain areas where such habitat is restricted (for example, only smaller stream or river deltas available), this could be an important effect during this period of relatively high energy requirement and limited resource availability. During the summer, nonbreeding individuals, failed breeders, and males may be feeding in nearshore or offshore areas. Helicopters flying over these areas 30-plus times per day could cause birds to move away from routinely used routes, increasing the stress of preparing for migration in some individuals and a decline in their fitness or survival.

Displacement from the vicinity of vessel transportation corridors may last through an entire open-water season depending on the number of concurrent projects and the stage of development that determines trip frequency. Although substantial numbers of vessel round trips (150-200/summer) for each development project are forecast during the construction period, supply vessels are likely to follow established routes, which would limit the actual area disturbed. The area would increase and, potentially, the numbers of individuals affected, if concurrent projects at different locations were developed. Vessel traffic occurs during the open-water season; therefore, although numbers of eiders displaced could be substantial (many tens of individuals during a season), alternate foraging and staging habitat would be available away from probable routes.

The presence of offshore or onshore facilities could cause eiders to avoid the immediate vicinity for variable periods up to the duration of such presence. However, adequate nesting habitat is not likely to be limiting factor in the Beaufort Sea area.

V.C.5.b(1)(b)2) Vehicle Disturbance

Substantial numbers of gravel truck passages per day plus other vehicle traffic along 364 miles of existing roads (Table V-3) were associated with the construction of causeways, pads for facilities, and roads in the expanding oil development around Prudhoe Bay. Frequent summer traffic in particular can disturb nesting eiders. Even lower, postconstruction traffic levels may continue to disturb eiders throughout the life of the field. Satellite expansion of the Prudhoe Bay development would require new access roads. Vehicle use of these roads may have additive though relatively small effects on the regional eider population (BPXA, 1998a), because relatively few birds would be affected. Also, at least some spectacled eiders apparently do not avoid nesting in the vicinity of roads or facilities (Troy Ecological Research Assocs., 1995a), and early season snowmelt in dust shadows of roads may attract nesting eiders. Little population effect is expected to result from these situations.

V.C.5.b(1)(b)3) Other Disturbance Factors

Human presence, construction and drilling activities, spill cleanup, and predators attracted to oil and gas development areas vary considerably in how much disturbance they cause. The presence of unconcealed humans, whether associated with oil and gas, hunting, or recreational activities, is disturbing to birds, especially during nesting and broodrearing periods. Common experience confirms that such presence generally causes birds to move from the immediate area of disturbance and may displace them for several hours or longer. Cumulative effects of such disturbance, with several activities occurring in the same period or one after the other through the summer season, could cause decreased production and survival of young or recruitment into the population. Attracted predators and hunting, of course, may cause direct mortality. Predators such as foxes attracted to nesting areas may cause losses up to total failure for the season. Most such disturbance associated with commercial activities could be controlled by mitigation. Although it is likely that behavioral effects resulting from disturbance associated with oil and gas development would be additive to naturally occurring disturbances, there is no evidence for synergism where the combination of effects from natural and/or development-related factors is greater than their additive effects.

V.C.5.b(1)(c) Habitat Alteration

Past development in the Prudhoe Bay region has resulted in habitat loss by the gravel burial of 7,126 acres, plus 1,601 acres of gravel mines, and 756 acres of reserve pits (Table V-3). Future development is expected to occur with a much smaller “footprint.” For example, local roads, pads, and airstrips for the Alpine and Badami projects are estimated to cover less than 100 acres for each development (Table V-5). The cumulative effects of future projects’ infrastructure on eider populations, although additive, presumably would be less severe because of the smaller areas involved. Effects from dust fallout, thermokarst, and hydrologic change (USDOI, MMS, 1998) would be restricted to much smaller areas and, thus, result in smaller habitat loss. The total area covered by roads/pads/airstrips for development of the Badami, Alpine, Northstar, and Liberty (if developed) prospects is 216 acres plus 170 acres of gravel mines. By comparison, these projects contain 12.5% as much estimated oil reserve as the Prudhoe Bay region but are estimated to cover only 5% as much area.

Habitat alteration associated with Sale 186 onshore construction is expected to contribute about 0.6% of that altered by Prudhoe Bay region projects (roads, pads, airstrips, gravel mines, pits). However, the pads would cover less than 1 acre of well-vegetated tundra wetland habitat preferred by birds for nesting, while Prudhoe region developments cover 7,126 acres of tundra. Considering just gravel structures covering tundra, that required for Alternative I for Sale 186 development would disturb 0.01% of the Prudhoe Bay region. Comparison of gravel mine areas alone indicates that Sale 186 development would disturb 2.1% of that area altered by development in the Prudhoe Bay region.

V.C.5.b(1)(d) Collision Effects

The low density of spectacled and Steller’s eiders in the Beaufort suggests that few fatalities from collision with offshore structures are likely to occur. Collision involving a flock could result in significant effect.

V.C.5.b(2) Transportation Effects on Spectacled and Steller’s Eiders

Oil produced by development of Alternative I for Sale 186 prospects is expected to contribute only a small fraction of unlikely future spills of arctic oil from Trans-Alaska Pipeline System tankers (0.41 spills or about 1% of 9.66 of past, present, and reasonably foreseeable estimated tanker spills, Table V-12). Although few of these spills are expected to reach areas of overwintering habitat that are critical to the survival of Steller’s eiders (from the Aleutian Islands to Cook Inlet); if they do, the oil is expected to be less harmful as a result of weathering and dispersion in the water. However, this threatened species is not likely to recover from any substantial oil-spill mortality that might occur. For example, the recovery period for the harlequin duck, classified as not recovering from effects of the *Exxon Valdez* oil spill (*Exxon Valdez* Oil Spill Trustee Council, 2001), already has spanned 4 generations. Recovery from a large spill may require a lengthy period, and it is complicated by other factors before and after the spill that increase mortality and/or decrease production of offspring. Spectacled eiders do not occur in areas that could be contacted by Trans-Alaska Pipeline System tanker spills.

According to spill simulations by LaBelle, Marshall, and Lear (1996), in the unlikely event a large oil spill occurs, the probability of a tanker spill greater than or equal to 1,000 barrels occurring 200 miles offshore along a Far East route and contacting sensitive coastal bird habitats within 30 days during the summer season is less than 0.5%. In the unlikely event a large oil spill occurs, the probability of contact in eider winter habitat within 30 days would be less than 5% in the lower Cook Inlet area and less than 24% in the Kodiak Island area. Elsewhere, contact probabilities are less than 0.5%. In general, the effect of tanker spills on the Steller's eider is expected to be about the same as described above and in Section IV.C.5.b.

V.C.5.b(3) Effects of Large Oil Spills

Although the magnitude of oil-spill effects is uncertain, in the unlikely event a large oil spill occurs during the life of relevant oil and gas projects (0.54 spills [the most likely number of spills is 0] greater than 1,000 barrels estimated to occur within about 28 years, Table V-12), it could result in significant losses of spectacled eiders, if it occurred during the prebreeding or postbreeding seasons when eiders might be staging in marine waters. A large offshore spill during the summer season could contact spectacled eiders staging offshore, although the number at risk in specific areas is not well known (Fischer, 2002; Fischer, Tiplady, and Larned, 2002). A Fish and Wildlife Service spill model for the Liberty Project suggests that only two individuals would be contacted by a large oil spill (5,912 barrels) and one by a 1,580-barrel spill (Stehn and Platte, 2000).

In addition to direct contact losses, any declines of benthic prey populations in foraging areas contacted by oil from a spill that is unlikely at any time of year may result in secondary impacts to eiders, affecting productivity and/or survival. Likewise, effects of a spill on shoreline and coastal marsh habitat and water quality may adversely affect spectacled eider productivity and survival in subsequent years. Effects resulting from development of Alternative I for Sale 186 projects would be additive to natural mortality and potentially could contribute significantly to cumulative effects in the highly unlikely event that a large offshore oil spill were to occur during the open-water season or its oil released from melting ice during breakup. Although it is likely that mortality resulting from oil spills would be additive to naturally occurring mortality, there is no evidence for synergism where the combination of effects from natural and/or development-related factors is greater than their additive effect.

In the unlikely event a large onshore spill occurs during the summer season, it may cause the loss of small numbers of nesting individuals. Most small spills, whether originating from pipelines or spills of refined products, are expected to be contained on gravel pads and/or cleaned up before eiders are contacted. Even if an onshore 720- to 1,142-barrel spill occurred during the summer season and entered freshwater aquatic habitat, eider mortality is likely to be few individuals. By comparison, and equally uncertain, some mortality could result from the small spills that are projected (82 spills, most of which are less than 1 barrel; Table A.1-6b) for the 28-year production life of prospects assumed in this cumulative analysis.

Summary and Conclusions for Effects of Beaufort Sea, North Slope, and Transportation Activities on Spectacled and Steller's Eiders. The effects from normal activities associated with cumulative exploration and development of oil and gas prospects in the Beaufort Sea are expected to include the loss of a small number of spectacled eiders. This is most likely to occur as a result of collisions with offshore or onshore structures. Declines in fitness, survival, or production of young may occur where birds are exposed frequently to various disturbance factors, particularly helicopter support traffic. The frequency of such disturbance is expected to be highest in the vicinity of primary support facilities. Overlap between cumulative project developments could increase disturbance effects. The spectacled eider population, currently declining at a nonsignificant rate, may be slow to recover from small losses or declines in fitness or productivity. No significant overall population effect is expected to result from small losses.

In the event a large oil spill occurs in the marine environment, spectacled eider mortality is expected to be less than 100 individuals; however, any substantial loss (e.g., 25+ individuals) would represent a significant effect. Mortality resulting from the cumulative effects of oil and gas projects would be additive to natural mortality and interfere with the recovery of the Arctic Coastal Plain population. Recovery from substantial mortality is not expected to occur while the population exhibits a declining trend, but determination of population status may be obscured by natural variation in population numbers. Although little Steller's eider mortality is expected from an oil spill, knowledge regarding their numbers and distribution in this region is insufficient to allow realistic calculation of risk or effects from cumulative adverse factors. Neither eider species is expected to experience synergistic effects from combinations of adverse factors.

Contribution of Alternative I for Sale 186 to Cumulative Effects: Contribution of Alternative I for Sale 186 to the cumulative case is likely to be about 4% of the local short-term disturbance and habitat alteration effects on eiders (based on the expectation that effects resulting from Beaufort Sea Sales 186, 195, and 202 exploration, development, and production activities would occur in the same proportion as is represented by the ratio of oil reserves estimated for this sale, 0.46 billion barrels, to cumulative oil reserves, 11.5 billion barrels [Table V-12]). It is estimated that the average number of cumulative offshore spills associated with the Beaufort Sea Multiple Sale is 0.11 (the most likely number is zero [Tables V-12, V-13]); this represents about 17 % (Table V-13) of cumulative offshore spills (0.65 [Table V-12], not including Trans-Alaska Pipeline System tanker spills).

Although development of an individual prospect represents a small proportion of cumulative oil-spill risk, it could contribute significantly to cumulative effects in the unlikely event a large oil spill occurs and contacts either eider species staging in offshore or nearshore areas. The number typically at risk of direct oil contact in the specific areas is unknown but may be relatively small. In addition, if benthic prey declines as a result of contact by oil from a spill at any time of year, secondary impacts to eiders may affect productivity and/or survival. Likewise, negative effects of a spill on coastal habitats and water quality may affect eiders adversely in subsequent years.

In the unlikely event a large oil spill occurs, mortality of spectacled eiders from a 720- to 1,142-barrel onshore spill estimated from Alternative I for Sale 186, for example, are expected to range from 0-1 bird (see Section III.C.2.a(2) in the Liberty final EIS [USDOI, MMS, Alaska OCS Region, 2002a] for details), although earlier in the nesting season a pair could be contacted and later, a female with brood. Greater though unknown mortality (estimated fewer than 20 individuals) could result from the numerous small spills (maximum of 82 ranging in size from 1 gallon to less than or equal to 500 barrels, for a total volume of 246 barrels from Alternative I for Sale 186 [Table IV.A-2]) that are projected for the estimated 28-year life of Alternative I for Sale 186 projects.

Disturbance of eiders by helicopter-support traffic for individual future offshore projects is expected to be about the same as that required for the Northstar Project, which included approximately 2,000 round trips for all construction activities completed during one year (U.S. Army Corps of Engineers, 1999: Table 4-13). This difference would decrease to about one-tenth of the total for such projects during the production phase. Habitat alteration onshore associated with locating and constructing individual offshore oil and gas projects is expected to be about 0.6-3.5% of the total altered by Prudhoe Bay region projects (roads, pads, airstrips, gravel mines [Tables V-3, V-5, and V-6b]). A comparison of gravel-mine areas and preferred tundra wetland nesting habitat likely to be disturbed by development projects with that disturbed at Prudhoe Bay shows that these could disturb 2.1% and 0.01%, respectively, of the area altered by Prudhoe Bay development. Also, although development projects are expected to contribute substantially to cumulative noise and habitat disturbance effects, this contribution will decrease considerably after construction is completed.

Tanker spills of arctic oil, an unlikely event, which would include only 0.41 spill potentially attributable to of 10.07 total spills (about 4% [Table V-12]), are unlikely to reach the most densely populated Steller's eider wintering areas along the Alaska Peninsula and Aleutian Islands.

Overall cumulative effects of Alternative I for Sale 186 would be additive to effects from all projects. Only in the case of a large offshore oil spill would these projects be expected to increase cumulative adverse effects to potentially significant population-level consequences.

V.C.6. Marine and Coastal Birds

V.C.6.a. Cumulative Effects on Marine and Coastal Birds

In addition to development of the prospects associated with Alternative I for Sale 186, other Federal and State projects and associated activities that could contribute to cumulative effects on birds seasonally occupying or resident on the Arctic Coastal Plain are outlined in Section V.C.5.b. Other projects and activities occurring on the Arctic Coastal Plain, along migration routes, or on winter ranges also could contribute to cumulative effects. These include subsistence and sport harvests, commercial fishing, commercial development, environmental contamination, marine shipping, and recreational activities. These projects and activities could result in (1) additional oil or other toxic pollution effects (see discussions in Sections IV.C.6); (2) additional disturbance during breeding and postbreeding periods; and (3) habitat degradation beyond what already has occurred in the Prudhoe Bay region.

V.C.6.b. Effects of Disturbance

Potentially disturbing factors associated with oil and gas development include aircraft, vessel, and vehicle traffic; human presence; construction of facilities and roads/pads; drilling operations; spill cleanup; and attracted predators.

V.C.6.b(1) Aircraft and Vessel Disturbance

Relatively large numbers of helicopter trips and substantial vessel traffic would be required to support offshore developments. Roadless developments such as Alpine, Badami, and any that occur in the National Petroleum Reserve-Alaska, also may require substantial air support for development, although most construction would be done during winter. Numbers of helicopter round trips (Table IV.A-4) required to support exploration (155/year), construction (1-2 years, 300-600/month), development (28-56/month), and production (12-28/month), Sales 186 and 195, with potential for some overlap and thus higher totals, could cause substantial increases in air traffic, amounting to perhaps 30-40 round trips per day. Regardless of any attempts to mitigate effects by adjusting routes, continued activity at this level to support developing fields and future development is likely to result in some low-altitude flights over nesting, broodrearing, molting, staging, or migrating birds. Such disturbance is expected to cause excessive short-term energy use by disturbed individuals and displacement of birds from the vicinity of routinely used air corridors. The latter would be similar to bird responses observed during low-level aerial bird-survey overflights where individuals dive, run across the water surface, or take flight, depending on species and circumstances. Such disturbance may flush females from nests resulting in lower productivity if eggs are lost to predators or exposure to low temperatures, or may cause displacement of females with broods from preferred foraging areas during broodrearing, or any individuals during preparation for migration. Long-term displacement (1 year or more) from the vicinity of heavily used corridors and offshore or onshore facilities may result in fewer young produced and somewhat lower survival of adults and young.

If aircraft frequently overfly open water off river deltas in spring, loons, king and common eiders, long-tailed ducks, and other species are likely to be displaced from this essential habitat. Because limited open water is available in spring, access to such areas is likely to be more restricted than in the postbreeding period. This could increase competition for the food available during this energetically stressful period following spring migration and could result in decreased survival or breeding success. In certain areas where such habitat is restricted (for example, only smaller stream or river deltas available), this could be an important effect during this period of relatively high-energy requirement and limited resource availability. During the summer, nonbreeding individuals, failed breeders, molting individuals, and males may be feeding in nearshore or offshore areas. Helicopters flying over these areas 30+ round trips per day could cause birds to move away from routinely used routes, increasing the stress of preparing for migration in some individuals and a decline in their probability of survival.

Displacement from the vicinity of vessel transportation corridors may last through an entire open-water season, depending on the number of concurrent projects and the stage of development, which determines trip frequency. Although substantial numbers of vessel round trips (30-60/month) for a project (Table IV.A-4) are forecast during construction period, supply vessels are likely to follow established routes, which would limit the actual area disturbed. The area would increase, and potentially the numbers of individuals affected, if concurrent projects at different locations were developed. Vessel traffic occurs during the open-water season and, although numbers of birds displaced could be substantial (many tens of hundreds or thousands of individuals during a season), alternate foraging and staging habitat would be available away from probable routes.

The presence of offshore or onshore facilities could cause loons, eiders, and other waterbirds to avoid the immediate vicinity for variable periods up to the duration of such presence. This potentially could result in lowered productivity although adequate nesting habitat is not likely to be limited in the Beaufort Sea area.

V.C.6.b(2) Vehicle Disturbance

Substantial numbers of gravel-truck passages per day plus other vehicle traffic along about 364 miles of existing roads (Table V-3) were associated with the construction of causeways, pads for facilities, and roads in the expanding oil development around Prudhoe Bay. Frequent summer traffic in particular can disturb molting waterfowl such as snow geese when they attempt to cross roads. Even postconstruction traffic levels (low volume) may continue to disturb some species throughout the life of the field. During development of the Lisburne field, geese and swans appeared tolerant of vehicle traffic on roads during most seasons; however, during broodrearing, they moved away from roads (Murphy and Anderson, 1993). Early season snowmelt in dust shadows of roads may attract nesting birds. The Lisburne development activities had no apparent effect on overall bird habitat use in the area. However, some species of shorebirds, such as the semipalmated sandpiper and the dunlin, were reduced in density (up to 40%) within about 100 meters of roads during breeding compared to postbreeding periods and undisturbed areas (Troy, 1988; Troy Ecological Research Assocs., 1993). Satellite expansion of the Prudhoe Bay development could require new access roads. Vehicle use of these roads is expected to have additive though relatively small effects on bird populations (BPXA, 1998a).

V.C.6b(3) Other Disturbance Factors

Human presence, construction and drilling activities, spill cleanup, and attracted predators associated with oil and gas development vary considerably in the severity of disturbance they cause. The presence of unconcealed humans, whether associated with oil and gas, hunting, or recreational activities, is disturbing to birds especially during nesting, broodrearing, and molting periods. Common experience confirms that such presence generally causes birds to move from the immediate area of disturbance and may displace them for several hours or longer. Cumulative effects of such disturbance, with several activities occurring in the same period or one after another through the summer season, could cause decreased productivity if eggs or young are exposed to predators or low temperatures, or decreased survival of young if left unprotected.

Predators and hunters cause direct mortality. Predators such as foxes attracted to island or colonial species' nesting areas may cause losses of varying severity including up to total destruction of the season's productivity (Quinlan and Lehnhausen, 1982). Foxes may have increased in certain areas because of reduced trapping efforts by local people. Most such disturbance associated with commercial activities could be controlled by mitigation. Although it is likely that behavioral effects resulting from disturbance associated with oil and gas development would be additive to naturally occurring disturbances, there currently is no evidence for synergism where the combination of effects from natural and/or development-related factors is greater than their additive effects.

Low-flying waterbirds, especially sea ducks and loons, may collide with offshore islands/structures under conditions of poor visibility (darkness, fog). Because present offshore production islands/structures cumulatively represent relatively small obstructions in the Beaufort Sea, and birds encountering them when visibility is good are expected to see and avoid them, bird mortality from collisions with an island or other structure is expected to be low. However, although it is not possible to determine whether recent (late September/early October 2001) bird fatalities (18 sea ducks) at the currently operational Northstar Island occurred during daylight or evening hours under good visibility or foggy conditions (but darkness also would obscure the facility), the largest, single-day total occurred during a foggy period (fatality data supplied by Taylor, 2001). Increasing numbers of structures associated with greater offshore production in the foreseeable future potentially could result in substantial mortality for several waterbird species. Collision involving flocks of common eiders, for example, could result in a significant effect. There is little information on which to base a projected mortality estimate.

V.C.6.c Effects of Habitat Alteration

Development in the Prudhoe Bay-Kuparuk area (not including Alpine, Badami) has resulted in habitat loss by gravel burial of 6,944 acres, plus 1,512 acres of gravel mines and 756 acres of reserve pits (Table V-3). Future development is expected to occur with a much smaller disturbed area (footprint). For example local roads, pads, and airstrips for the Alpine and Badami projects are estimated to cover less than 100 acres for each development (Table V-5). Presumably, the effect of facilities for future projects on bird populations, though additive, would be substantially less severe because of the smaller areas involved. Such effects as from dust fallout, thermokarst, and hydrologic change (USDOI, MMS, 1998) would be restricted to much smaller areas and, thus, result in smaller habitat loss. For example, the total area covered by roads/pads/airstrips for the Badami, Alpine, Northstar, and Liberty (if developed) prospect areas is about 216 acres plus 170 acres of gravel mines. These projects are estimated to contain 12.5% as much estimated oil reserve as the Prudhoe Bay region but would cover only 5% as much area.

Habitat alteration associated with Sale 186 onshore construction is expected to contribute about 0.6% of that altered by Prudhoe Bay region projects (roads, pads, airstrips, gravel mines, and reserve pits; Table V-3). However, the pads would cover less than 1 acre of well-vegetated tundra wetland habitat potentially used by birds for nesting while Prudhoe region developments cover 7,126 acres of tundra. Considering just gravel structures covering tundra, that required for Alternative I for Sale 186 development would disturb about 0.01% of that disturbed in the Prudhoe region. Comparison of gravel mine areas alone indicates that Sale 186 development would disturb 2.1% of that altered by Prudhoe region development. Withdrawal of freshwater from lakes during winter for construction of ice roads and pads is expected to have almost no effect on tundra-nesting bird populations. Water used for this purpose is replaced rapidly by snowmelt runoff in spring; therefore, it is not likely that waterbodies depleted somewhat in winter would present decreased foraging opportunities for birds. Also, species of concern due to small and/or declining populations are present at low density on the coastal plain so it is unlikely that more than a very few individuals would by chance attempt to nest at lakes used as winter water sources. In addition, most species potentially affected are not considered habitat limited because they have rather general nest site requirements, so acceptable nesting habitat is widely available if areas used for water withdrawal lack some necessary characteristics.

V.C.6.c(1) Effects of Natural Events

On August 10, 2000, a violent windstorm occurred in the Beaufort Sea producing extreme wave action that eroded coastlines and restructured barrier island habitats. The storm was followed by several days of subnormal temperatures and 1.5 inches of snow (Divoky and Mendenhall, 2000). Many islands were heavily eroded, with some sloping shores converted to cliffs, and low-lying spits and islands were inundated. The immediate effect may have been the loss of common eider broods; at one of the two principal island study sites for the MMS-sponsored Beaufort Waterfowl Project, only one brood was observed following the storm. However, perhaps most importantly, much of the accumulated driftwood typically used by common eiders for nesting habitat on barrier islands was swept away; investigators at the study island estimated that three quarters of the driftwood disappeared. The ultimate effect of this aspect is difficult to gauge, because it is not known how quickly new driftwood will accumulate on the islands. It also is not possible to estimate the extent of and long-term effect of brood loss associated with this event. However, the declining status of this population plus the potential for greatly reduced nesting habitat in the immediate future suggests that recovery from any short-term losses associated with oil and gas development could be hindered by lowered productivity.

V.C.6.c(2) Effects of Large Oil Spills

Although the magnitude of oil spill effects is uncertain, in the unlikely event a large offshore oil spill occurs during the life of relevant oil and gas projects, the 0.65 spill (the most likely number of spills is zero) of greater than or equal to 1,000 barrels estimated to occur within about 28 years (Table V-12) may result in losses exceeding 10,000 individuals if it is released during the summer/fall season when marine and coastal birds are present. This primarily would involve large flocks of postbreeding waterfowl and shorebirds staging offshore, in lagoons, or along beaches before migration. In addition to direct contact losses, any declines of benthic prey populations in foraging areas contacted by oil from a spill at any time of year may result in secondary impacts to birds affecting productivity and/or survival. Likewise, negative effects of a spill on shoreline and coastal marsh habitat and water quality may affect several species of shorebirds and waterfowl adversely in subsequent years.

Although highly unlikely, development of these prospects potentially could result in the release of a large oil spill into the offshore marine environment and, thus, contribute significantly to cumulative effects for some species such as long-tailed duck and king and common eider. Using average estimated bird density calculated from Fish and Wildlife Service survey data, and average severity of spill-trajectory paths and thus exposure of birds to oil, a Fish and Wildlife Service model estimates, for example, that at average bird densities and severity of oil-spill movement an average of 1,443 long-tailed ducks, 232 king eiders, 147 scoters, 159 common eiders, 217 glaucous gulls, and 23 Pacific loons could be exposed to a large spill (5,912 barrels) within 30 days in July (see details in Section IV.C.6, and Stehn and Platte, 2000). It is likely that mortality resulting from oil spills would be additive to naturally occurring mortality; however, there currently is no evidence for synergism where the combination of effects from natural and/or development-related factors is greater than their additive effect.

In addition to direct mortality, any declines in oiled bottom-dwelling prey organisms could result in secondary impacts such as decreased survival and/or productivity of sea duck species that forage on the bottom. A large onshore spill during the summer season may cause losses of up to hundreds of individual molting and broodrearing waterfowl if it enters a heavily used lake or coastal marsh habitat, plus smaller numbers of nesting waterfowl, shorebirds, and passerines. Small spills, whether originating from field pipelines or spills of refined products, are expected to be contained on gravel pads and/or cleaned up before substantial losses occur. However, some mortality could result from projected small spills (82 spills, most of which are less than 1 barrel, Table A.1-6b) for the 28-year production life of prospects assumed in this cumulative analysis.

Spills from the Trans-Alaska Pipeline System pipeline are not expected to cause substantial losses of those species occurring in the Beaufort Sea region. Tanker spills of North Slope crude oil in the Gulf of Alaska could cause substantial losses of migrating shorebirds and waterfowl that use Beaufort Sea habitats during the breeding season if major stopover areas such as the Copper River Delta and Prince William Sound were contacted. In the latter area in addition to bays to the west and lower Cook Inlet, overwintering loons, sea ducks, and gulls could take major hits if contacted by an oil spill.

V.C.6.c(3) Transportation Effects

V.C.6.c(3)(a) Effects of Disturbance

Disturbance effects primarily would result from helicopter traffic during inspection of the Trans-Alaska Pipeline System. The corridor from which individuals of at least some species likely would be displaced is estimated to be within 1 kilometer (0.62 miles) of the Trans-Alaska Pipeline System. Although such flights occur frequently, they are intermittent, thus some species may tolerate this level of disturbance and nest, rear their broods, or forage within the pipeline corridor.

In addition, tanker traffic transporting North Slope oil through Prince William Sound and the Gulf of Alaska is likely to result in some intermittent disturbance of marine birds along and/or displacement from the tanker route. In terms of displacement of birds from foraging areas along the route this is likely to represent a minor effect since there are alternate foraging sites available throughout these areas with similar prey available. Also, forage fishes that constitute the principal prey of many marine bird species are highly mobile and not likely to remain for long periods only in the tanker route corridor. Further discussion of aircraft and vessel disturbance effects is included in Section IV.C.6.a(1)(a)1).

V.C.6.c(3)(b) Effects of a Pipeline Spill

In the unlikely event of a large oil spill from the Trans-Alaska Pipeline system, some habitat in the immediate vicinity of the pipeline that is contacted by oil would become unsuitable for nesting, broodrearing, or foraging by birds. Oil entering freshwater aquatic habitats could spread more widely, including into river deltas and nearshore marine habitats, and result in death of birds contacted and/or a larger area unsuitable for the above activities. Loons, waterfowl, and shorebirds are likely to be the groups most adversely affected.

V.C.6.c(3)(c) Effects of a Tanker Spill

Oil produced by development of Alternative I for Sale 186 is expected to contribute only a small fraction of future spills of arctic oil, considered to be unlikely events, from Trans-Alaska Pipeline System tankers (0.41 spills or about 1% of 9.66 total estimated tanker spills [Table V-12]). However, future tanker spills of arctic oil, which may include oil from Alternative I for Sale 186, could cause serious effects on marine and coastal birds in Prince William Sound and the Gulf of Alaska. In these instances, the contribution of oil from Alternative I for Sale 186 to overall effects is expected to be proportional to its percentage in the particular shipment.

The principal example for estimating potential effects in Prince William Sound and the northern Gulf of Alaska are those resulting from the *Exxon Valdez* oil spill, an unusually large spill (Table V-14). Following the *Exxon Valdez* spill, more than 30,000 dead oiled birds were collected, most of them outside Prince William Sound (Piatt et al., 1990). The actual toll probably was 3-10 times this number. Species that have recovered or are recovering include the bald eagle, black oystercatcher, marbled murrelet, and common murre *(Exxon Valdez* Oil Spill Trustee Council, 2001). Those that are not recovering or recovery is unknown include the common loon, cormorants, harlequin duck, pigeon guillemot, and Kittlitz's murrelet. The recovery period for these species already has spanned up to four generations; recovery from an event of this magnitude obviously requires a lengthy period and is complicated by other factors before and after the spill that increase mortality and/or decrease production of offspring. Potential effects of a large spill between April and September within 50 miles of shore in the Gulf of Alaska are discussed in Section IX.B.3 of the Liberty final EIS (USDOI, MMS, Alaska OCS Region, 2002a).

A more realistic projection of the risk from tanker spills is indicated by the average estimated size of tanker spills (Table V-15) that were calculated from tanker spill records (Table V-14). Most spills (9 of 10) are expected to average 13,000 barrels or less (Table V-15). Of these, four likely would occur in ports with readily available containment and cleanup equipment. When the effects have been studied, at-sea spills of this size have not been found to cause serious effects on bird populations. Also, they are not expected to reach large areas of habitat that are critical to the survival of bird populations until the oil is rendered much less harmful by weathering and dispersion in the water. This suggests that for spills of this size, mortality would be relatively low and recovery periods could be relatively short, except for species whose populations are declining and/or have a low reproductive rate (for example, sea ducks). Recovery periods would be lengthened if more than one spill affected the same populations within a short interval, which is unlikely to happen.

In the unlikely event a large spill of oil produced by cumulative arctic oil development occurs along the transportation route in the Gulf of Alaska, marine and coastal bird populations could be affected. According to spill simulations by LaBelle and Marshall (1995), a large tanker spill assumed to occur 100-200 miles offshore would not be expected to contact sensitive coastal bird habitats for more than 30 days (model spills 80-100 miles offshore contacted shore in 30 days), at which point, the oil would have weathered and dispersed. In addition, bird densities generally are quite low in the pelagic habitat. Shearwaters, kittiwakes, and various species of auks probably are most vulnerable. If a tanker spill occurred, the probability of bird contact in summer or winter habitat within 30 days would be less than 0.5%. The effect of such a spill on overwintering waterfowl in the Gulf of Alaska is likely to be substantial.

In-port spills are likely to be contained and recovered or cleaned up relatively quickly. Vulnerable species during winter and spring/fall migration would include loons, waterfowl, shorebirds, and some auks; in summer, herons, rails, and various seabirds would be the main groups affected.

Most projects and activities not associated with petroleum development affect birds at latitudes south of the Beaufort Sea and outside the summer breeding season. Several of these factors, individually or in combination, probably affect bird populations as much or more than potential effects of petroleum development and may have contributed importantly to recent declines in these populations.

Summary and Conclusions for Effects of Beaufort Sea, North Slope, and Transportation Activities on Marine and Coastal Birds. The effects from normal activities associated with cumulative exploration and development of oil and gas prospects in the Beaufort Sea are expected to include the loss of small numbers of several waterfowl and loon species. This is most likely to occur as a result of collisions with offshore or onshore structures, which are expected to increase in number in association with reasonably foreseeable future development, although they still would be considered very infrequent obstacles.

Declines in fitness, survival, or production of young may occur where birds are exposed frequently to various disturbance factors, particularly helicopter support traffic. Human presence that disturbs nesting or broodrearing birds, or attracts predators, may result in predation of unprotected eggs or young. Because of a smaller disturbed area, the effect of future projects' infrastructure on bird populations, although additive to natural effects, is expected to be less severe than previous development in the Prudhoe Bay region. The frequency of such disturbance is expected to be highest in the vicinity of primary support facilities at Deadhorse. Overlap between cumulative project developments could increase disturbance effects. Several waterbird populations, currently declining at non-significant or significant rates, may be slow to recover from small losses or declines in fitness or productivity. No significant overall population effect is expected to result from small losses. However, for species such as the common eider that are experiencing a population decline, recovery from any short-term losses associated with oil and gas development could be hindered by lowered productivity resulting from natural occurrences. For example, greatly reduced potential nesting habitat resulting from the major storm in August 2000 could substantially reduce productivity in the region.

In the event a large oil spill occurs in the marine environment, mortality of tens of loons, hundreds of king and common eiders, and thousands of long-tailed ducks (potentially could exceed 10,000 for the latter) is possible; any substantial loss of long-tailed ducks or common eiders would represent a significant effect. Mortality resulting from the cumulative effects of oil and gas projects would be additive to natural mortality and interfere with the recovery of these species' Arctic Coastal Plain populations. Recovery from substantial mortality is not expected to occur while the population exhibits a declining trend, but determination of population status may be obscured by natural variation in population numbers. Onshore spills, also considered unlikely to occur, are expected to be contained and cleaned up; however, a spill entering a lake could cause substantial losses of molting and broodrearing waterfowl plus smaller losses of nesting waterfowl, shorebirds, and passerines. Any tanker spill in the Gulf of Alaska could cause substantial losses of migrating shorebirds and waterfowl that use Beaufort Sea habitats during the breeding season, or of overwintering loons, sea ducks, and gulls.

Overall cumulative effects of oil-industry activities on marine and coastal birds potentially could be substantial in the case of loon species and the king eider, and significant in the case of long-tailed duck and king and common eiders, primarily as a result of mortality in the unlikely event a large oil spill occurs. Although the chance of oil-spill occurrence is relatively small (8-10%), the potential is highest for contact with bird concentrations in the vicinity of primary support facilities in the central Beaufort, where most projects assumed in the cumulative case likely will occur. Also, as a result of the apparent decline in populations of some species (for example, several sea duck species), and the challenge of recovering spilled oil, particularly in broken-ice conditions, there is uncertainty as to the ultimate effect of any spills on bird populations. Disturbance may cause some small loss of productivity and lowered fitness or survival of birds occupying areas with high levels of industry-activity, but these effects are not expected to be significant. Effects resulting from oil and gas development activities likely would be additive to naturally occurring effects. No bird species are expected to experience synergistic effects from combinations of adverse factors.

Contribution of Alternative I for Sale 186 to Cumulative Effects: Contribution of Alternative I for Sale 186 to the cumulative effects is likely to be about 4% of the local, short-term disturbance and habitat alteration effects on marine and coastal birds (based on the expectation that effects resulting from Beaufort Sea exploration, development, and production activities for Sales 186, 195, and 202 would occur in the same proportion as is represented by the ratio of oil reserves estimated for this sale (0.46 billion barrels) to cumulative oil reserves (11.5 billion barrels) (Table V-12). It is estimated that the average number of cumulative offshore spills associated with the Beaufort Sea sales is 0.11 (the most likely number is zero [Tables V-12, V-13]); this represents about 17% (Table V-13) of cumulative offshore spills (0.65 [Table V-12], not including tanker spills).

Alternative I for Sale 186 could contribute substantially to losses of waterfowl and shorebirds occupying lagoons in the area from an offshore spill. The number typically at risk of direct oil contact is unknown for most species. In addition, if benthic prey declines as a result of contact by oil from a spill at any time of year, secondary impacts to eiders may affect productivity and/or survival. Likewise, effects of a spill on coastal habitats and water quality may affect eiders adversely in subsequent years. Mortality associated with an onshore spill could be up to a few hundred individuals. Bird mortality from the numerous small spills that are projected for the 28-year life of the oil and gas projects in this analysis is not expected to be substantial, although if lakes supporting concentrations of molting or broodrearing waterfowl are contacted, mortality would be higher.

Disturbance of birds by supply helicopter traffic for Alternative I for Sale 186 is expected to be greater than for individual onshore projects due to potential overflight of waterfowl and shorebird, nesting (barrier islands) molting and staging habitat. Habitat alteration caused by Alternative I for Sale 186 onshore construction is small. Overall effects of Alternative I for Sale 186 would be additive to effects observed or anticipated for the other projects in this cumulative analysis. In the case of oil spills, it could increase adverse effects and cause significant regional population effects in species such as the long-tailed duck and king and common eider that concentrate in local lagoons and could cause substantial effects in other regional populations of waterbirds.

V.C.7. Seals, Walruses, Beluga Whales, Polar Bears, Sea Otters, and Other Marine Mammals

V.C.7.a. Effects of Noise and Disturbance on Pinnipeds and Beluga, and Gray Whales

In the Beaufort Sea, noise and disturbance from on-ice seismic surveys during any one year would affect breeding ringed seals in that area for no more than 1 year, because only a small fraction (less than 1%) of the population is likely to be exposed to and potentially be disturbed by the operations. Subsequent surveys in other areas during other years have disturbed different seals and would be expected to in the future. A few pups could be lost, because mothers may abandon maternity lairs or because seismic vehicles may destroy snow lairs along the shot line. Past seismic exploration on the sea ice over several years might have killed some pups and displaced some seals locally very near seismic lines (within 150 meters) during operations for that ice season (Burns et al., 1983; Link, Olson, and Williams, 1999). However, these additive effects probably were not significant to the seal population above changes in distribution associated with changes in sea ice.

Noise and disturbance effects on seals, walruses, and beluga and gray whales in the Beaufort Sea from an estimated total of more than 450 helicopter round trips per month and at least 200 vessel round trips per month should last only a few minutes to less than an hour for any one disturbance event. Disturbance reactions of seals, walruses, and beluga and gray whales would be brief; they would return to normal behavior patterns and distribution shortly after the boat, seismic vessel, or aircraft has left the area. Effects are not expected to be additive or synergistic, because disturbance reactions most likely would involve different animals and occur in different areas. Seals and walruses also may get used to aircraft and vessels, if they saw them often and routinely.

Ringed and bearded seals, walruses, and beluga and gray whales have been exposed to oil-exploration activities in the Beaufort Sea, including seismic surveying, drilling, air and vessel traffic, dredging, and gravel dumping (Map 2). These activities in the Beaufort Sea, barge traffic to the North Slope, and some icebreaker activity to support oil exploration might increase in the future. These activities could affect how seals are distributed near the activity for 1 season or less than 1 year during high levels of activity. However, some seals will get used to marine and air traffic, industrial noise, and human presence. Displacement from cumulative industrial activities is not likely to affect the overall abundance, productivity, or distribution of ringed and bearded seals, walruses, and beluga whales in Alaska's Beaufort Sea.

Cumulative noise sources that may affect beluga and gray whales are from seismic activities and drilling, and other noise associated with exploration, development, and production operations; vessel and aircraft traffic; construction; and oil-spill cleanup. Underwater industrial noise, including drilling noise measured from artificial gravel islands, has not been audible in the water more than a few kilometers away. Because the beluga whale's migration corridor is far offshore of the barrier islands, seismic exploration, drilling, development, and production noise from most development in the nearshore area for Alternative I for Sale 186 is not likely to reach many migrating beluga or gray whales. Noise also is unlikely to affect the few whales that may be in lagoon entrances or inside the barrier islands due to the rapid attenuation of industrial sounds in a shallow-water environment. Because island and pipeline construction would occur during the winter and be well inside the barrier islands, it is not likely to affect beluga or gray whales.

V.C.7.b. Effects of Noise and Disturbance on Polar Bears

Individual air- and vessel-traffic disturbances assumed for this analysis likely would disturb a few polar bears for a few minutes to less than an hour. Seismic operations, ice-road traffic, and other activities could disturb some coastal denning sites in Alaska. A few females may have abandoned maternity dens because of nearby noise and humans, and some cubs might have been harmed. However, the number of bears disturbed in any given year is likely to be very low (probably no more than 1-3 animals). Bears disturbed in one year are not expected to be disturbed the next year, because they would not den at the same location due to changes in snow cover. Current information of the distribution of den locations near oil facilities does not show that bears were permanently displaced from denning habitat. There is no clear indication that disturbance from oil exploration and development has had an additive or synergistic effect on the polar bear population. "Two hunters from Nuiqsut reported that polar bear activity has decreased in recent decades around Prudhoe Bay and west, to the Colville River," while " some hunters stated that the number of polar bears varies from year to year but has remained stable overall" (Kalxdorff, 1997).

The Marine Mammal Protection Act requirements should prevent excessive disturbance to polar bears. Letters of Authorization for incidental take of polar bears requested by industry and issued by the Fish and Wildlife Service recommend a 1-mile buffer around occupied polar bear dens. Compliance with the Letter of Authorization is expected to avoid any significant disturbance of polar bears in the Beaufort Sea.

A very small number of polar bears have been and could be killed in encounters with humans near industrial sites and settlements associated with cumulative oil development. In the Northwest Territories in Canada, conflicts with humans near industrial sites from 1976-1986 accounted for 15% (33 out of 265) of the polar bears killed (Stenhouse, Lee, and Poole, 1988). Some of these losses were unavoidable, and the polar bear population recovered through recruitment within 1 year. Four bears were unavoidably killed after being attracted to offshore platforms in the Canadian Beaufort Sea during 5 years of intensive oil exploration (Stirling, 1988). Fewer losses of polar bears in arctic Alaska are expected, because the Marine Mammal Protection Act requires that the oil industry avoid killing any bears. Polar bear loss in Alaska is not likely to exceed more than one animal per year, and it probably would be less. Only three lethal takes of polar bears were related to industrial activities on the North Slope over the past 20 years (Gorbics, Garlich-Miller, and Schliebe, 1998). These losses have not significantly increased the mortality rate of the polar bear population over that from subsistence harvest and natural causes. The loss rate in Canada over a 5-year period was higher than that in Alaska but was not significant to the population, which increased at 2.4% per year. The Marine Mammal Protection Act has kept losses low in Alaska. The act did not cover bears during the extensive oil explorations in Canada.

V.C.7.c. Effects of Habitat Alteration

More than 40 exploration-drilling units (gravel islands, drill ships, and other platforms) have been installed or constructed in the Beaufort Sea as a result of past Federal and State oil and gas leases. Several million cubic yards of gravel and dredge-fill material have altered at least a few square kilometers of benthic habitat in the Beaufort Sea. Alterations from island construction, trench dredging, and pipeline burial are expected to affect some benthic organisms and some fish species within 1 kilometer for less than 1 year or season. These activities also may temporarily affect the availability of some local food sources up to 1-3 kilometers (0.62-1.9 miles) distance during island construction. These activities are not expected to affect food availability over the long term for the following reasons:

- Common prey species for seals, such as arctic cod, have a very broad distribution and would not suffer from the fractional loss of benthic habitat associated with platforms and pipelines.
- Ringed and bearded seals and walruses can forage over large areas of the Beaufort Sea; they do not rely exclusively on the abundance of local prey.
- Gravel islands used for oil production may provide habitat for some prey species. They are not likely to affect the availability of seals and walruses as prey for polar bears in the Beaufort Sea.

Drilling units for exploration and platforms for future production (including gravel islands) in the Beaufort Sea are likely to have only local effects on ice movements and fast-ice formation around the structures. These local changes in ice movements and ice formation are not likely to change the seal distribution. Noise, movements, and human presence associated with installing platforms and other construction activities could displace some seals, walruses, beluga whales, and polar bears within 1 mile of the activity for 1 season or year. Exploration platforms have not had any apparent lasting effect on seal, walrus, beluga whale, gray whale, and polar bear distribution and abundance in the Beaufort Sea. The number of production platforms in the Beaufort Sea over the next 20 years is uncertain. An optimistic estimate would be about eight platforms, which include six platforms from Sales 186, 195, and 202; Liberty; and Northstar. That number is not expected to affect ice habitats of seals and polar bears in the Beaufort Sea. Natural variation in ice conditions and resulting changes in the distribution of seals, walruses, beluga and gray whales, and polar bears are likely to reverse or overwhelm any local reduction (or increase) in their distribution because of cumulative exploration and production.

V.C.7.d. Effects of Hunting and Harvesting on Pinnipeds, Polar Bears, and Beluga and Gray Whale Populations

International subsistence hunting of seals and polar bears would have no more than a very short-term effect on the abundance of these species (USDOI, MMS, 1998).

V.C.7.e. Effects of Large Oil Spills on Pinnipeds, Polar Bears, and Beluga and Gray Whales

Cumulative risks from oil spills assumed for purposes of analysis to seal, walrus, beluga whale, gray whale, and polar bear habitats in the Beaufort Sea would be higher than risks from Alternative I for Sale 186 alone (0.11 mean number of spills). That compares to the 0.65 mean number of spills for the cumulative analysis (Table V-12); the most likely number of spills is zero. A spill that might occur in the Beaufort Sea during the summer or that occurred during the winter and persisted after meltout would pose the highest risk to the marine mammals' flaw-zone habitats, which are offshore from about Cape Halkett east to offshore of Prudhoe Bay (Table A.2-19, ERA 32). During spring, ringed and bearded seals and polar bears could contact the oil spill in this habitat. During the summer (open-water) season, resident ringed and bearded seals, polar bears, and migrant seals, walruses, and beluga and gray whales in the western Beaufort Sea could contact a spill that might occur to the east during winter, contact the flaw-zone habitat, and then melt out. The most noticeable cumulative effects of a potential oil spill would be from direct oiling of ringed, spotted, or bearded seals; walruses; and polar bears. These species could suffer the following estimated mortalities should a spill occur:

- Perhaps 100-200 ringed seals out of an estimated population of about 40,000.
- Perhaps 10-100 bearded seals out of a population of several thousand.
- Perhaps 6 up to 10 polar bears out of a population of 1,800 assuming a bear density of 1 bear per 25 square kilometers) see Section IV.C.7.
- Perhaps a small number of beluga and gray whales and maybe a few walruses would be exposed to the spill and may be affected. Few if any walruses or beluga and gray whales are expected to be killed by the assumed oil spill. We assume environmental degradation resulting from the oil spill is below the level that would alter reproduction and survival of the polar bear population.

In addition to direct contact with oil, ingesting oil or loss of thermal insulation could cause the death of very young seal pups, walrus calves, and highly stressed adults. Seals, walruses, polar bears, and beluga and gray whales are likely to replace their losses within 1 year, and additive and synergistic effects are not expected.

V.C.7.f. Transportation Effects on Sea Otters, Harbor Seals, and Other Marine Mammals

Although Alternative I for Sale 186 likely would not contribute any tanker spills to the cumulative analysis (mean number of spills 0.41 in Table V-12), potential future oil-spill effects from tanker transportation of arctic oil (including oil from Alternative I for Sale 186) from the Trans-Alaska Pipeline System terminal at Valdez could have cumulative effects on marine mammals, especially sea otters, in Prince William Sound and the Gulf of Alaska. There also could be local effects on harbor seals, as resulted from the 1989 *Exxon Valdez* oil spill. It is likely that local assemblages of sea otters in heavily contaminated coastal areas of Prince William Sound would take 5-10 years or longer to recover from the spill.

Future transportation of North Slope oil through Prince William Sound could have a long-term (5 years or longer) effect on sea otters and harbor seals. The contribution of Beaufort Sea Sales 186, 195, and 202 to tanker spills is estimated to be zero spills (Table V-12). We estimate the number of cumulative tanker spills to be 10 (Table V-15); 7 with an average size of 4,000 barrels, 2 with an average size of 13,000 barrels, and 1 with an average size of 250,000 barrels (Table V-15). These spills are expected to have similar effects on sea otters and harbor seals as described but cause fewer losses of otters and seals. Recovery of populations is expected within 1 or 2 years after the spills, assuming the same populations and habitats are not affected. If two or more of these spills affect the same populations and habitats within 1 or 2 years of the previous spill, recovery would take longer (perhaps 10 years or more).

If tanker spills associated with oil development in arctic Alaska, including Alternative I for Sale 186, occurred south of the Gulf of Alaska, other nonendangered marine mammals and their habitats could be affected along the transportation routes or at marine ports. The effects of tanker spills on these marine mammals and their habitats are expected to be about the same as described above and in Section IX.B for seals, sea otters, and cetaceans in the Gulf of Alaska of the Liberty final EIS (USDOI, MMS, Alaska OCS Region, 2002a).

V.C.7.g. Summary and Conclusions for Beaufort Sea, North Slope, and Transportation Activities on Seals and Polar Bears

Beaufort Sea Sales 186, 195, and 202 and other ongoing or planned projects (Map 2) may affect ringed and bearded seals, walruses, beluga and gray whales, and polar bears by causing noise and disturbance, altering habitat, and accidentally spilling oil.

V.C.7.g(1) Effects of Noise and Disturbance and Habitat Alteration

Only three “lethal takes” of polar bears were related to industrial activities on the North Slope over the past 20 years (Gorbics, Garlich-Miller, and Schliebe, 1998). These small detectable losses of polar bears have had no effect on the population. More than 40 exploration-drilling units (gravel islands, drill ships, and other platforms) have been installed or constructed in the Beaufort Sea as a result of past Federal and State oil and gas leases. These activities may have displaced a few bears during island construction but have had no detectable effect on the polar bear population. The Fish and Wildlife Service concluded that existing onshore development, proposed exploration activities, and the Northstar development would have negligible effects on polar bears (65 *FR* 16828).

Development would alter a small amount of the habitat at the one production island for Alternative I for Sale 186 versus an estimated 40 past or existing exploration and production platforms in the Beaufort Sea. These platforms have not had any apparent lasting additive or synergistic effect on seal, walrus, beluga whale, gray whale, and polar bear distribution and abundance in the Beaufort Sea. The number of production platforms in the Beaufort Sea over the next 20 years is uncertain, but an optimistic estimate would be about eight, which includes six from Sales 186, 195, and 202; Liberty; and Northstar. That number is expected to have little or no effect on the ice habitats of seals and polar bears in the Beaufort Sea.

Alternative I for Sale 186 is expected to contribute about 2-4% of the local short-term noise and disturbance effects on seals and polar bears (based on 10-20 flights per day/450 helicopter roundtrips/day during busy construction periods on the North Slope). Activities from Alternative I for Sale 186 should only briefly and locally disturb or displace a few seals, walruses, beluga and gray whales, and polar bears. A few polar bears could be temporarily attracted to the production island, with no significant effects on the population's distribution and abundance.

V.C.7.g(2) Effects of Oil Spills

Over their lifetime, fields from Alternative I for Sale 186 would contribute a mean (0.11) number of spills to potential offshore oil spills and potential effects on seals and polar bears. The estimated mean number of cumulative offshore spills is 0.65, but the most likely number of offshore spills is 1 (Table V-12). The contribution of spilled oil from Alternative I for Sale 186 is estimated at 0.11 spills, with the most likely number of spills being zero (Table V-12). The estimated 6-10 or fewer polar bears lost to a large (greater than or equal to 1,000-barrel) spill assumed under the cumulative analysis represents a severe event. The more likely loss of polar bears from Alternative I for Sale 186 development would be fewer than six bears, assuming a bear density of one bear per 25 square kilometers (Amstrup, Durner, and McDonald, 2000). In the likely cumulative case, pinnipeds, polar bear, and beluga and gray whale populations in the Beaufort Sea Planning Area are expected to recover within 1 year, assuming one large spill (greater than or equal to 1,000 barrels) occurs. Alternative I for Sale 186 is expected to contribute 0.41 spills and about an equal fraction of the potential oil-spill effects on other marine mammals along the tanker route to the U.S. West Coast. Potential cumulative oil spills along the tanker route to the U.S. West Coast could have long-term (more than perhaps 5-10 years) effects on sea otters and other marine mammals.

Conclusion. The overall effects (mainly from one oil spill assumed for this analysis) is the potential losses of perhaps up to 10 polar bears and a few hundred seals, and walruses, and small numbers (probably less than 10) of beluga and gray whales. In the likely cumulative case, pinnipeds, polar bear, and beluga and gray whale populations are expected to recover within 1 year, assuming only one large spill (greater than or equal to 1,000 barrels) occurs. Potential cumulative oil spills along the tanker route to the U.S. West Coast could have long-term (more than one generation or perhaps 5-10 years) effect on sea otters and perhaps harbor seals and other marine mammals. Cumulative noise and disturbance in the Beaufort Sea Planning Area is expected to briefly and locally disturb or displace a few seals, walruses, beluga and gray whales, and polar bears. A few polar bears could be temporarily attracted to the production island, with no significant effects on the population's distribution and abundance.

Contribution from Alternative I for Sale 186 to Cumulative Effects. The contribution of Alternative I for Sale 186 is expected to be about 2-4% of the local short-term disturbance and habitat effects on pinnipeds, polar bears, and beluga and gray whales (based on 0.46-billion barrel/11.5-billion barrel oil reserves in Table V-12). Alternative 1 for Sale 186 likely would contribute about 17% of cumulative offshore spills. The estimated mean number of cumulative offshore spills is 0.65, but the most likely number of offshore spills is zero (Table V-12).

V.C.8. Terrestrial Mammals

V.C.8.a. Overall Effects on Terrestrial Mammals

Cumulative oil and gas activities on the Arctic Slope of Alaska has had some local effects on the Central Arctic caribou herd's calving distribution and use of habitats within 4 kilometers (2.48 miles) of oil field roads and other facilities. A shift in calving activities away from the oil fields may mean the caribou have lost some calving habitat (Nellemann and Cameron, 1998). Aircraft and ice-road traffic (the latter during winter only) from Alternative I for Sale 186 and other recent projects could disturb some caribou, muskoxen, and other terrestrial mammals for a few minutes to an hour, but they would not affect population distribution or abundance. Caribou would not be disturbed by ice-road traffic during calving, because ice roads melt in the spring and are no longer used when caribou are calving.

Activities such as gravel mining and the construction of roads and gravel pads have reduced local use of nearby habitat because of additive levels of vehicle traffic during operations. Caribou cows with calves tend to avoid roads with vehicle traffic. These effects are long lasting but local (within 4 kilometers of roads with traffic) and would displace some caribou from part of the calving range. If this displacement/avoidance were to include more calving habitat and affect the distribution of more calving caribou, the herd's productivity could be affected. However, we do not now see such an effect, because development in the Prudhoe Bay area has not clearly affected the abundance of the Central Arctic Herd (Cronin, Whitlaw, and Ballard 2000; Ballard, Cronin, and Whitlaw, 2000). This herd had declined from 23,000 in 1992 to about 18,000 animals in 1994, and reduced weights of cow-caribou that calve on the oil fields suggest that their productivity may be affected by oil development (Cameron, 1994; Needleman and Cameron, 1996, 1998). However, this decline may reflect natural changes in forage habitat and in caribou abundance. Recorded differences in calf numbers between cows calving west (on the main oil fields) versus east (of the main oil fields) of the Sagavanirktok River only occurred during years of low overall calf production; however, during years of high calf production, there are no differences (Whitten, 1998, pers. commun.). This finding indicates that factors other than or in addition to oil development are affecting caribou productivity (Whitten, 1998, pers commun.). The most recent estimate for the Central Arctic Herd caribou is more than 27,000 animals (Lawhead and Prichard, 2001).

Constructing more than 400 miles of roads to support oil development has increased human access to the Arctic caribou herds, muskoxen, grizzly bears, and arctic foxes. However, hunting regulations should keep hunters from overharvesting any of the caribou herds and other terrestrial mammal populations on the North Slope. Ongoing oil-development projects such as Badami and Alpine, and future projects such as Alternative I for Sale 186, would have smaller "footprints" (fewer and smaller gravel pads, fewer infield roads, and no roads connecting to Prudhoe Bay). Limiting construction at developing oil fields (Badami and Alpine) to winter months and not building roads that connect to Prudhoe Bay have minimized or avoid disturbance and displacement of caribou from calving areas.

This technology likely would reduce additive effects of development on terrestrial mammal habitats. These measures would greatly reduce the amount of habitat affected by oil-development and reduce disturbance of caribou and muskoxen from vehicles, especially during the calving season. Future oil-development projects that do not include interconnecting roads should not significantly disturb or displace calving caribou or muskoxen. They also would not greatly change caribou and muskoxen movements across the Arctic Slope.

V.C.8.b. Effects of Oil Spills

For this cumulative analysis, we assume one offshore oil spill greater than 1,000 barrels would occur from Alternative I for Sale 186. The mean number of spills greater than 1,000 barrels is 0.65, and the most likely number of spills is zero (Table V-12). If the spill occurred during the open-water season or during the winter and melted out of the ice in the spring, this oil could affect coastal habitats from about Harrison Bay east to about Flaxman Island. Thus, some caribou of the Central Arctic and Teshekpuk Lake herds (the latter herd could be affected by the spill that might occur west of Alternative I, Sale 186) could be directly contacted and harmed by the spill along the beaches and in shallow waters while they are escaping from insects. However, even in a severe situation, only a few to fewer than 100 caribou are likely to contact the spilled oil and die from inhaling and absorbing toxic hydrocarbons. Either of the caribou herds would replace these losses within 1 year.

The most likely number of onshore crude oil spills is 5 (assumed size 500-1,142 barrels), which likely would occur near pipelines, including the Trans-Alaska Pipeline System, for the cumulative analysis ((Table V-12). These minor spills would have a very small additive effect on terrestrial mammal habitats near pipelines, roads, and other facilities (see Section V.C.7 - Cumulative Effects on Vegetation and Wetlands). Some of these spills would contaminate 1 acre or less of tundra vegetation near the pipeline, road, or gravel pads. Alternative I for Sale 186 would contribute about 0.41 Trans-Alaska Pipeline System tanker spills (Table V-12). Caribou and muskoxen probably would not ingest oiled vegetation, because they are selective grazers and are particular about the plants they consume (Kuropat and Bryant, 1980). Also, control and cleanup operations (ground vehicles, air traffic, and humans) at the spill site would frighten caribou and other terrestrial mammals away from the spill and prevent contact with the oil. Thus, onshore spills from cumulative oil development are not likely to affect caribou, muskoxen, or other terrestrial mammal populations.

V.C.8.c. Effects of Disturbance on Caribou Movements and Calving

The main sources of disturbance for caribou are traffic from surface-vehicles, human presence, and aircraft near cows with newborn calves. Further oil exploration, particularly helicopter traffic, briefly would disturb some caribou when the traffic passes overhead. This activity has not and would not affect caribou populations. However, during development, concern exists about disturbance from traffic on roads next to pipelines and traffic on roads that cross calving habitats. Caribou hesitate crossing under an elevated pipeline next to a road when vehicles are moving on the road. Their success in crossing depends on motivation. When mosquitoes and oestrid flies pester them, caribou are highly motivated to seek relief. They cross under pipelines more often during the insect season in the Prudhoe Bay-Kuparuk area (Curatolo, 1984), but increased disturbances from vehicle traffic can keep crossing-success rates down. However, caribou do successfully cross pipeline-road complexes and many highways in Alaska and Canada with no apparent effect on the herd's distribution or abundance. Although caribou can get used to roads and traffic, cows and calves avoid areas of human activity before and during the calving season (Smith, Cameron, and Reed, 1994).

Several hundred vehicles per day travel along more than 400 miles of roads in the Prudhoe Bay area. This traffic has displaced caribou for a few minutes up to several days within about 1-2 kilometers of the road system. Road traffic temporarily delays some animals from crossing under pipelines but has not affected the herd's overall distribution or abundance. However, where roads cross calving areas, any vehicle traffic could disturb cows during calving, displacing many of them up to 4 kilometers away from the road (Dau and Cameron, 1986a,b; Cameron et al., 1992; Nellemann and Cameron, 1996). This local displacement continues to persist every year during the calving season. Calving also has shifted to the west and southwest of the Kuparuk oil field (Lawhead et al., 1997; Nellemann and Cameron, 1998). However, during the postcalving season when caribou are harassed by insects (oestrid flies), Central Arctic Herd caribou are attracted to gravel pads, pipelines, and other oil-field facilities to avoid or reduce their exposure to insect harassment (Noel et al.,1998; Curatolo and Murphy, 1986). The caribou's use of gravel pads and roads for insect relief may compensate for the loss of foraging habitat at the pad sites and may compensate somewhat for the disturbance they experience when road traffic is present (a countervailing effect).

At present, oil development on the North Slope has produced 754 miles of pipelines, over 400 miles of roads, and 7,805 acres of habitat covered by gravel pads, mines, reserve pits, and other facilities (Tables V-3 and V-5). All this activity has caused some additive displacement of Central Arctic Herd caribou from part of the calving range with no apparent effect on the herd's abundance or overall productivity. There is no evidence that synergistic effects have occurred.

In theory, reducing calving use of habitats within 4 kilometers of roads on the North Slope eventually could limit the growth of arctic caribou herds within their present ranges. It may even keep the herds from reaching the population size they could achieve on these ranges without development. However, existing cumulative oil development has not been shown to affect caribou abundance or population growth. Recent information suggests the Central Arctic Herd caribou may be calving better east of the oil fields, which could mean that disturbance and local displacement of some cow caribou may affect their productivity (Cameron, 1994; Nellemann and Cameron, 1996, 1998). If future construction activity, especially road traffic, avoided calving concentration areas and construction activities and road traffic was restricted just before, during, and just after calving, caribou would experience less disturbance and displacement from calving areas.

V.C.8.d. Effects of Oil Development Projects without Connecting Roads

Offshore Beaufort Sea developments, Badami, Alpine, and other recent projects would not have roads constructed that connect with Prudhoe Bay (Map 2). This measure would save the oil companies millions of dollars and would avoid disturbing caribou along the pipeline corridors during the calving season. The Badami and Alpine projects would have short gravel roads between airstrips, docks, camps, and production pads (see Table V-6a). The Alpine Project, however, is not located in a caribou calving area. Badami is near calving areas near Bullen Point and southward between the Shaviovik and Staines rivers. Vehicles moving along ice roads between the airstrips and production pads or between the airstrip and the dock could disturb some caribou moving during the winter. This local disturbance would not greatly change caribou movements or displace calving caribou. As more vehicles move along the Endicott Road during Alternative I for Sale 186 and Badami development, they temporary could disturb more caribou, but they are not likely to affect caribou movements and distribution in the Sagavanirktok River area.

V.C.8.e. Effects of Construction and Supply Helicopter Traffic

The 10-20 flights per day during 2-3 years of development from Alternative I for Sale 186 could briefly disturb some caribou, muskoxen, and grizzly bears. Cumulatively, these animal populations see more than 450 helicopter round trips/day during busy construction periods on the North Slope. Alternative I for Sale 186 would increase air traffic by 2-4% overall (10-20 flights/450 flights per day). Disturbance events are not likely to be cumulative, because they would be rather infrequent and involve different animals and different areas.

V.C.8.f. Effects of Construction and Supply Ice-Road Traffic

Construction traffic and about 100 supply trips per year for Alternative I for Sale 186 briefly could disturb some caribou, muskoxen, and grizzly bears during December through early May. This traffic would be highest during the 2 years of development and would continue at a lower level to support project operations during the 15-20 years of production. These animals have experienced ice-road traffic from other projects over the past 20 years without any apparent effect on their abundance or distribution. Ice roads for future and ongoing projects, such as development from Alternative I for Sale 186 and Northstar, also likely would not affect terrestrial mammal abundance or distribution.

V.C.8.g. Effects of Ice Roads, Gravel Mining, and Constructing Onshore Pipelines and Gravel Pads

For Alternative I for Sale 186, these activities would alter perhaps 50 acres of terrestrial mammal habitats. Existing development has altered more than 7,800 acres.

A gravel road would not be constructed along the onshore pipelines connecting production facilities from Alternative I for Sale 186 to other common-carrier pipelines. Disturbance of caribou would be limited to helicopter traffic during the summer and winter and ice-road traffic during the winter. Central Arctic Herd caribou see thousands of motor vehicles each month on more than 400 miles of roads in the Prudhoe Bay area during and after calving. This traffic has caused a decrease in calving near roads and temporarily changed the caribou's movements. Assuming future activities do not include roads connecting the Prudhoe Bay-Dalton Highway road system, this development is not expected to cause further displacement of Central Arctic Herd caribou from calving habitat nor affect caribou movements.

V.C.8.h. Effects of Interactions with Humans

The onshore activity for Alternative I for Sale 186 (12-50 miles of onshore pipeline but no camp onshore) is not likely to result in the loss of any bears. However, some grizzly bears have been killed or removed from the oil fields because of confrontations with people or because the bears were damaging buildings or equipment. Arctic foxes actually have increased around the Prudhoe Bay area, because they have more food (garbage) and shelter (in culverts and under buildings). Future development activities could result in the loss of some additional grizzly bears, but the numbers are likely to be small and would not affect the population.

V.C.8.i. Effects of Altering Habitat

Oil development on the North Slope covers more than 7,800 acres (Tables V-3, V-4, and V-6b) and includes more than 400 miles of gravel roads that cross much of the Central Arctic Herd caribou's calving range. This extensive development actually has destroyed only about 3% of the tundra grazing habitat because of roads, pads, gravel quarries, pipelines, pump stations, and other facilities. Construction in ongoing and future oil developments (such as Northstar, Alpine, and Alternative I for Sale 186 projects) would alter much smaller areas of the available grazing habitat.

Roads for development on the North Slope eventually may be open to the public, which would increase access to the caribou herds, muskoxen, grizzly bears, and other terrestrial mammals, possibly leading to more hunting and disturbance. Although people cannot hunt caribou with firearms within 5 miles of the Dalton Highway, they can hunt with bows and arrows. Noise and disturbance from this harvest is not expected to significantly affect caribou movements across the Dalton Highway or other roads on the North Slope. Caribou have continued to cross roads and highways, even under heavy hunting pressure and the associated noise and disturbances (Valkenburg and Davis, 1986). However, if the public, through future development activities, were allowed access to the caribou calving areas during the calving season, such disturbance could have effects on the caribou population.

V.C.8.j. Transportation Effects on River Otters and Brown and Black Bears

Alternative I for Sale 186 likely would not contribute any tanker spills to the cumulative analysis (the mean number of spills is 0.41 [Table V-12]). However, potential future oil-spill effects from tanker transportation of arctic oil (including from Alternative I for Sale 186) from the Trans-Alaska Pipeline System terminal at Valdez could have local cumulative effects on river otters and brown and black bears and other terrestrial mammals in Prince William Sound, the Gulf of Alaska, or along the tanker route to the West Coast. The potential loss of river otters (perhaps 50-100 individuals) and contamination of intertidal habitats from a 250,000-barrel oil spill likely would take more than 1 year to recover (probably 3 years or longer). The potential loss of brown and black bears (perhaps 10 individuals) likely would take 1 year for the populations to recover. We estimate the number of cumulative tanker spills to be 10 (Table V-15); 7 with an average size of 4,000 barrels, 2 with an average size of 13,000 barrels, and 1 with an average size of 250,000 barrels. These spills likely would have similar effects on river otters and bears as described, but fewer losses of river otters and bears. Recover of populations is likely within 1 or 2 years after each spill, assuming the same populations and habitats are not affected by multiple spills. If two or more of these spills affect the same populations and habitats within 1 or 2 years of the previous spill, recovery will take longer.

If tanks spills associated with cumulative oil development in arctic Alaska, including from Alternative I for Sale 186, occurred south of the Gulf of Alaska, other terrestrial mammals and their habitats could be affected along the transportation routes or at marine ports. The effects of tanker spills on these terrestrial mammals and their habitats are expected to be about the same as described for the effects on tanker spills in the Gulf of Alaska.

Conclusion. Terrestrial mammals that would be affected include caribou, muskoxen, grizzly bears, and arctic foxes. Oil development in the Prudhoe Bay area could continue to displace some caribou during the calving season within about 4 kilometers (2.48 miles) of some roads with vehicle traffic that crosses calving habitat. The general shift of caribou calving away from the extensive oil fields may persist. Cows and calves of the Central Arctic Herd caribou may, over time, reduce calving and the use of summer habitats near roads with high levels of traffic. If they do, these activities potentially could affect the caribou's productivity and abundance over the long term. However, this potential effect may not be measurable, because the caribou's productivity greatly varies under natural conditions. Some oil-development projects, such as Badami and Alpine, do not include roads constructed to connect to Prudhoe Bay and the Dalton Highway. They are not likely to disturb or displace calving caribou or change caribou movements across the Arctic Slope. Cumulative oil development is likely to have only local effects on the distribution and abundance of caribou, muskoxen, arctic foxes, and grizzly bears on the North Slope of Alaska but not affect overall distribution and abundance. Potential cumulative oil spills along the tanker route to the U.S. West Coast could have short-term (1-3 years) effects on other terrestrial mammals.

Contribution of Beaufort Sea Sale 186 to Cumulative Effects: The contribution from Alternative I for Sale 186 to the cumulative case is expected to be about 4% of the local short-term disturbance and habitat effects on of caribou, muskoxen, grizzly bears, and arctic foxes and zero reduced use of habitat for calving (based on 0.46-barrel/11.5-barrel oil reserves [Table V-12]). It could attract few if any foxes to facilities and construction sites, with no effects on distribution and abundance. Alternative I for Sale 186 is estimated to contribute about 17% of cumulative offshore spills. The estimated mean number of cumulative offshore spills is 0.65, but the most likely number of offshore spills is zero (Table V-12).

V.C.9. Vegetation and Wetlands

V.C.9.a. Cumulative Effects on Vegetation and Wetlands

Cumulative development has directly covered more than 7,800 acres through the construction of 402 miles of roads, 95 gravel pads, 10 airports and airstrips, and 17 gravel mines. The mines alone cover more than 1,846 acres (TablesV-3, V-5, and V-6b) Development in the Prudhoe Bay and Kuparuk areas has directly affected about 9,666 acres by extracting and filling with gravel and indirectly affected many adjacent acres of vegetation (Walker et al., 1986, 1987). However, the total acreage is a small part of the Arctic Coastal Plain, and these effects probably are not significant to the overall productivity of tundra plants in this area. No synergistic effects are expected.

Present-ongoing oil-development projects, such as Alpine, Badami, and Northstar, and Beaufort Sea Sales 186, 195, and 202, would include much smaller acreage than existing and past projects on the North Slope (see Tables V-3 and V-5). Advances in drilling technology have allowed industry to drill more wells from fewer exploration and production pads than were required by past exploration and existing oil production in the Prudhoe Bay complex. This technology is expected to reduce additive effects of development on wetlands. Development plans that do not include interconnecting roads to the Trans-Alaska Pipeline System and the Dalton Highway also would greatly reduce the amount of affected vegetation and wetlands on the Arctic Slope.

V.C.9.b. Risks of Offshore Oil Spills from Production Contacting Vegetation and Wetlands

Estimated oil production from Alternative I for Sale 186 (0.46 billion barrels) represents about 4% of the total oil production (11.50 billion barrels) onshore and offshore from Alaska's Arctic Slope (Table V-12). Oil developed from Alternative I for Sale 186 would contribute about 7% of future offshore oil. The estimated mean number of cumulative offshore spills is 0.65, but the most likely number of offshore spills is zero (Table V-12). The estimated contribution of spilled oil offshore from Alternative I for Sale 186 is 0.11 spills, with the most likely number of spills being zero (Table V-12). Oil spills from Alternative I for Sale 186 would contribute 0.41 mean number of spill from the total estimated from the Trans-Alaska Pipeline-Tanker System. The chances of an oil spill occurring and contacting vegetation are highest (greater than 15% up to 21%) with wetlands in coastal habitats from Dease Inlet, Cape Simpson east to Atigaru Point-Kogru River (Land Segments 26, 28-33, and 47), and Kaktovik area (Land Segment 74) that have the highest conditional risks of spill contact, assuming spills occur during the summer season and contact the coastline within 30 days (Table A.2-27 from either LA1-LA18 or P1-P13). Additively, there is a 9-73% conditional chance oil will spill and contact the shoreline somewhere in the planning area within 30 days (Table A.2-21 contacts to Land). We assume that one large offshore oil spill greater than or equal to 1,000 barrels would occur during development over the life of these potential fields. Complete recovery of oiled coastal wetlands could take several decades to fully recover from this spill and associated cleanup activities.

V.C.9.c. Cumulative Effects of Onshore Spills on Vegetation and Wetlands

The most likely number of onshore crude spills is 5 (assumed size of 500-1,142 barrels), which likely would occur near pipelines, including the Trans-Alaska Pipeline System, for the cumulative analysis (Table V-12). The additive effect of those spills would cause very minor ecological harm; vegetation should recover within a few years but may take more than 20 years. Most onshore spills occur on gravel pads, and their effects do not reach the vegetation. About 20-35% of past spills of crude oil reached areas beyond pads. The corresponding proportion for refined oil probably is much less, but we assume that .27% of all onshore spills would occur at or reach beyond gravel pads. These percentages translate to 388-591 spills totaling 1,502-2,628 barrels of oil. Because winter spans most of the year, about 60% of the time spills occur when workers can clean up oil on the snow cover before it reaches the vegetation. Thus, we estimate that 11% of all onshore spills would affect vegetation (37-65 spills). Most spills would cover less than 500 square feet, or 0.01 acre, but may cover up to 4.8 acres if the spill is a windblown mist. We assume 98% of the spills would cover 0.01 acre, and 2% would cover 4.8 acres. Over the lifetime of developed oil fields, spilled oil most likely would cover about 6.5 acres (65 spills x 0.1 acre). Overall, past spills on Alaska's North Slope and along the Trans-Alaska Pipeline System have caused minor ecological damage, and ecosystems have shown a good potential for recovery (Jorgenson, 1997).

V.C.9.d. Effects of Construction of Onshore Pipelines, Gravel Pads, Roads, and Gravel Mining

Cumulative oil fields on the North Slope include more than 750 miles of pipelines, 95 gravel pads, about 400 miles of roads, and 17 gravel mines (Tables V-3, V-5, and V-6b).

V.C.9.d(1) The Effect of Constructing Onshore Pipelines

The pipeline for Alternative I for Sale 186 would remove a few acre of vegetation at the Point Thomson or Smith Bay landfall and along the 12- or 50-mile long pipeline to existing facilities. Vegetation would be removed at excavations for vertical support members (about 90-100 pilings/mile) along the elevated pipeline connecting to existing facilities. The gravel pads would be a small area (less than 1 acre) of overlapping impacts on tundra vegetation from both Alternative I for Sale 186 and the existing pipelines.

For this analysis, we assume vertical support beams would support pipelines. The beams would be 12 inches in diameter and would be placed 55-70 feet apart. Each support beam would disturb about 20 inches of vegetation around it in addition to the vegetation it directly displaces (Jorgenson, 1997, as cited in U.S. Army Corps of Engineers, 1998). The disturbance zone could come from locally deposited excess trench material and possible thermokarsting; it could change the composition of plant species. Each vertical support beam would disturb about 4 square feet of vegetation, 6% of which would be destroyed or replaced. This would result in 0.03 acre being disturbed per pipeline mile, or 0.36-1.5 acre from Alternative I for Sale 186. This would represent a very small fraction of the acreage affected by the existing 550 miles of pipeline in the Prudhoe Bay area (Tables V-3 and V-5).

Pipelines also could harm vegetation indirectly through snow drifting or shading from the pipeline. Information about snow drifting around pipelines with no parallel road is inconsistent (Jorgenson, 1997, as cited in U.S. Army Corps of Engineers, 1998), but residents of Nuiqsut say it happens. Any vegetation under a pipeline would receive slightly less direct sunlight during the growing season, potentially leading to a slightly shallower active layer in the soil and slightly reduced photosynthesis by the plants.

V.C.9.d(2) Cumulative Effects of Gravel Pads

Gravel fill for the Prudhoe Bay area (pads, mines, reserve pits, airstrips, and pipeline ramps) covers more than 7,800 acres (Tables V-3, V-5, and V-6b). This cover has directly destroyed some tundra vegetation. Within a few feet of a pad, the dust and gravel may smother the original vegetation. Weedy species and thermokarsting replace it, with the latter leading to high-centered polygons with deep moats (Jorgenson, 1997, as cited in U.S. Army Corps of Engineers, 1998).

The type of material used for gravel fill also can affect vegetation, because it sometimes has a salty source. If the material is salty, water draining from or leaching through the pad can pick up the salt and kill plants near the pad. More halophytic (salt-loving) plant species eventually colonize these areas, changing one plant community to another.

Rehabilitation of gravel pads on the Kuparuk oil field has resulted in the robust growth of grasses-sedges within 2 years, but recovery of shrubs has been slow (Cater, Rossow, and Jorgenson, 1999). Natural recovery of abandoned gravel pads has been slow (30-year period), but grasses-sedges have colonized old pads with plant cover similar to undisturbed adjacent tundra (Bishop et al., 1999).

From 1968-1983, flooding from construction caused the greatest indirect effect on vegetation in the Prudhoe Bay oil field (Walker et al., 1986, 1987). Flooding resulted when roads and pads intercepted the natural flow of water and caused ponding. Thus, the Beaufort Sea project area, through Corps of Engineers permits, would need to have natural drainage patterns identified before construction, and they would have to be maintained during and after construction. Even if such conditions were not required, or were not completely successful, flooding would affect no more land than that affected by dust and snow, as previously described. The change in vegetation from flooding could result in more aquatic grasses and sedges versus dwarf shrubs.

Alternative I for Sale 186 would require two valve stations. These stations and a helicopter pad would require less than 1 acre of gravel fill. We assume the perimeter of this gravel fill would encompass about 11 acres of potential dust effect and changes in moisture, a small fraction of the tundra affected by existing projects.

Gravel pads for future development activities are expected to have similar local effects on vegetation and wetlands.

V.C.9.d(3) Cumulative Effect of Gravel Roads and Onshore Ice Roads

There are more than 400 miles of gravel roads in the Prudhoe Bay development area (Tables V-3, V-5, and V-6b). Construction of these roads has caused the removal or burial of more than 4,000 acres of tundra-wetland-vegetation and has flooded an additional 4,000 acres of adjacent tundra because of changes in water flow due to the roads. However, development for Alternative I for Sale 186, Badami, Alpine, and most other proposed projects would not require the construction of interconnecting access roads next to elevated onshore pipelines tying into the Trans-Alaska Pipeline System and the Dalton Highway. The

Badami and Alpine projects would contribute only a few miles of additional roads, and Alternative I for Sale 186 would not contribute any effects in this area.

Ice roads would melt and become green later in the spring than the adjacent tundra, resulting in "green trails" along their routes. Ice roads tend to compress and flatten (but not kill) the vegetation under them, and we expect this vegetation to recover within a few years. Several hundred to more than a thousand miles of ice roads have been built over the tundra to support oil and gas exploration on Alaska's Arctic Slope. Alternative I for Sale 186 and future development would include perhaps a few hundred to several hundred miles of ice roads, but most of them would be offshore over landfast ice. The ice roads for Alternative I for Sale 186 would run between Endicott and Foggy Island Bay at the production island site and to the Kadleroshilik River mine site. These ice roads would not affect vegetation or wetlands along the coast, except for short-term, local effects where the roads cross the land. The use of freshwater from ponds and lakes for ice-road and pad construction are expected to have a negligible effect on vegetation-wetlands. We assume currently implemented stipulations on ice roads and pads would be followed for the exploration and development from Alternative I for Sale 186 and for future oil-exploration and -development projects. Onshore ice roads between gravel-mine sites, freshwater supplies, and other support areas temporarily would alter nearby vegetation. Ice and gravel roads for future development activities are expected to have similar local effects on vegetation and wetlands.

V.C.9.d(4) Cumulative Effects of Gravel Mining

The 17 mines around Prudhoe Bay area have removed more than 1,800 acres of tundra vegetation (Tables V-3 and V-5). Gravel mines for the Badami Project has altered another 89 acres, and gravel mines for Alternative I for Sale 186 development could alter additional acres. Future development is expected to alter the same amount or less acreage of tundra vegetation for gravel mines and have local effects on North Slope wetlands.

V.C.9.e. Effects of Future Oil Development Projects

If companies develop the Sourdough and Yukon Gold oil prospects west of the Canning-Staines rivers and the Point Thomson and Flaxman prospects along the Beaufort Sea's coast east of Badami (Table V-6a), these projects may tie into the Badami pipeline (Maps 1 and 2). Companies would add more gravel pads, pipelines, mine sites, and other facilities that would cause some further loss of vegetation and wetlands between the Sagavanirktok and Canning rivers. Developing the Alpine, Fiord, Colville, and Kalubik prospects in the Colville Delta, and possibly other oil prospects in the Prudhoe Bay area (Maps 1 and 2) would affect vegetation and wetlands that are west of the Sagavanirktok River to the Colville Delta.

Future exploration and development of oil and gas on the National Petroleum Reserve-Alaska would alter or destroy some vegetation and wetland on that part of the Arctic Slope. However, such losses likely would be small compared to the overall amount of vegetation and wetlands on the Arctic Slope. Future projects would use fewer and much smaller gravel pads and roads (smaller footprint) than existing oil fields in the Prudhoe Bay-Kuparuk River complex.

Conclusion. Oil-field development on Alaska's North Slope centers on the Arctic Coastal Plain, which covers about 13 million acres. Existing gravel-mine reserve pits, pads, and other facilities cover more than 7,800 acres (Tables V-3 and V-5). About 50 miles of shoreline, including vegetation and wetland habitats, potentially would be affected by cumulative development within the Alternative I for Sale 186 area. (See Section III.B.8 for a description of the distribution of vegetation and wetland in the project area.) All projects in Maps 1 and 2 either have or would destroy vegetation through construction of onshore gravel pads, gravel mines, and roads; burial of pipelines; or installation of vertical support members for elevated pipelines. Sources of past and potential impacts include directly digging up and burying vegetation; changes in snow drifting and water drainage; accumulation of dust, salt, and chemicals along roads and near gravel pads; and damage from oil spills and other accidental chemical spills. In terms of acres of land affected, construction causes more than 99% of the effects, with spills having a very minor role. Rehabilitation of gravel pads can result in the growth of grasses-sedges within 2 years after abandonment of the pads. Natural growth of plant cover on abandoned gravel pads would be very slow.

Construction of existing facilities, past exploration pads, and vehicle tracts across the tundra landscape has affected a small percentage of the total tundra-wetland habitats on the Arctic Coastal Plain. However, local additive effects of gravel pads, roads, mines, and other facilities on tundra wetlands are expected to persist decades long after the oil fields are abandoned.

We assume one large offshore oil spill greater than or equal to 1,000 barrels would occur during development over the life of these potential fields. Complete recovery of oiled coastal wetlands could take several decades to fully recover from this spill and associated cleanup activities.

Contribution of Alternative I for Sale 186 to Cumulative Effects: Alternative I for Sale 186 would contribute about 4% of the cumulative disturbance effects on over 7,800 acres of tundra and wetlands now affected by oil development (based on 0.46-barrel/11.5-barrel oil reserves [Table V-12]). Alternative I for Sale 186 is estimated to contribute about 18% mean number of cumulative offshore spills. The estimated mean number of cumulative offshore spills is 0.65, but the most likely number of offshore spills is zero (Table V-12). We expect no synergistic effects.

V.C.10. Economy

V.C.10.a. Background of Cumulative Effects on State and Borough Economies

Without the activities considered in the cumulative-effects analysis described in Section V.B, the onshore and offshore oil industry in and near Prudhoe Bay probably would decline. That is, exploration, development and production and its associated direct employment could decline. Accordingly, associated indirect employment in Southcentral Alaska, Fairbanks, and the North Slope Borough and revenues to the Federal, State, and North Slope Borough governments could decline. Fluctuations in oil prices and other factors generated fluctuations throughout the Alaska economy from 1975-1995 (McDowell Group, Inc., 1999). The Alaska economy currently is not nearly as dependent on the oil sector as it was in the mid-1980's, when the major crash in the Alaska economy occurred. Activities described in Section V.B generate employment, create economic opportunity, and add benefit to the cash economy of Alaska.

The oil and gas industry with interests in and near Prudhoe Bay and the Trans-Alaska Pipeline System have a strong interest in using the pipeline system many years into the future. The pipeline system represents a tremendous capital investment. Extending the useful life of the pipeline allows society to receive returns from its investment further into the future than would be the case if oil development on the North Slope ceased. In November 2002 an EIS was written and the TAPS Right-of-Way was renewed for another 20 years by both State and Federal agencies.

The oil and gas industry has reduced the costs of drilling wells and bringing new fields into production. This has made it more economic to develop fields that require more pipeline, both onshore and offshore, to connect to the existing pipeline system. Examples of this are the onshore pipelines that in recent years extended eastward and westward from Prudhoe Bay to the Badami and Alpine prospects, respectively. These onshore pipelines, and other possible future extensions proximate to the Beaufort Sea coast, make it more economic to develop offshore prospects. This can be done by extending pipelines northward to the offshore, including the OCS. The North Star development is an example of an extension of pipeline northward from previously existing pipeline infrastructure to the offshore. Future development prospects, which potentially may fit this geographic and economic pattern, are described in Section V.B.

In the following, we assess cumulative effects on the economy in terms of (1) current conditions, described in Section III.C.1; (2) economic effects from Alternative I for Sale 186 described in Section IV.C.10; and (3) activities considered in cumulative-effects analysis described in Section V.C.

V.C.10.b. Cumulative Effects on State and Local Revenues

The National Petroleum Reserve-Alaska alone would generate considerable revenues in the future. According to the final EIS for the Northeast National Petroleum Reserve-Alaska Integrated Activity Plan (USDOI, BLM, and MMS, 1998), oil from the Reserve at $18 a barrel could generate additive annual revenues of:

- $28 million State and North Slope Borough share of royalty receipts
- $3 million property tax to the State
- $48 million severance tax to the State
- $28 million Federal share of royalty receipts

For purposes of analysis, we presume that the $28 million royalty receipts will be divided so that the State receives $13 million and the Borough $15 million.

Not counting the National Petroleum Reserve-Alaska, other components of the cumulative case could generate the following additive annual revenues:

- $15 million State share of royalty receipts
- $7 million State income tax
- $4 million State spill and conservation tax
- $41 million Federal share of royalty receipts
- $56 million Federal income tax

In total, the cumulative case would generate the following additive annual revenues:

- $15 million to the North Slope Borough
- $90 million to the State
- $125 to the Federal Government

V.C.10.c. Cumulative Effects on Employment and Personal Income

The cumulative gains in direct employment would include additive jobs in petroleum exploration, development, and production, plus oil spill cleanup. The direct employment would generate indirect and induced employment and associated personal income for all the workers. This cumulative case is projected to generate additive employment and personal income increases as follows:

- 160 jobs annual average for North Slope Borough residents during development, declining to 40 during production. These include direct oil industry employment, indirect and induced employment.
- $10 million in total average annual personal income for workers residing in the North Slope Borough during development, declining to $2.8 million during production.
- 5,800 jobs annual average during development, declining to 3,300 during production. These jobs are for workers on the North Slope who reside in Southcentral Alaska and Fairbanks. These include direct oil industry employment and indirect and induced employment.
- $367 million in total average annual personal income for workers residing in Southcentral Alaska and Fairbanks during development, declining to $211 million during production.
- 5,800 jobs annual average during development, declining to 3,300 during production. These jobs are for workers who reside in the rest of the U.S. These include indirect and induced employment generated by expenditure for goods and services used on the North Slope and spending by direct employees.
- $367 million in total average annual personal income for workers residing in the rest of the U.S. during development, declining to $211 million during production. This income is for indirect and induced workers generated by expenditure for goods and services used on the North Slope and spending by direct employees.
- 60-190 jobs for 6 months for cleanup of unlikely oil spills in the Beaufort Sea.

This information is derived from Section IV.C.10 of this EIS and Section V.C.11 of the Liberty final EIS (USDOI, MMS, Alaska OCS Region, 2002a).

V.C.10.d. Cumulative Effects on Transportation

In the unlikely event of a spill of 250,000 barrels of oil in the cumulative case in the Beaufort Sea, activities associated with cleaning it up would employ about the same number of workers as associated with the *Exxon Valdez* spill: 10,000 cleanup workers worked for 6 months in the first year, declining to zero by the fourth year following the spill, along with price inflation above 25% during the first 6 months of the cleanup operation. These workers also are additive workers. See Section IX.B.3.k of the Liberty final EIS (USDOI, MMS, Alaska OCS Region, 2002a) for details. The same economic effects could occur whether the spill was in the Gulf of Alaska or farther south along the Canadian or U.S. West Coast bordering on the Pacific Ocean. These are additive workers.

V.C.10.e. Cumulative Effects of Subsistence Disruptions on the North Slope Borough's Economy

The cumulative effect of disruptions to the harvest of subsistence resources could affect the economic well-being of North Slope Borough residents mainly by the loss of some part of those resources. See Section V.C.11 for effects on subsistence-harvest patterns.

Conclusions. The cumulative case would generate additive annual revenues and additive employment and personal income increases as follows. In total, the cumulative case would generate the following additive annual revenues:

- $15 million to the North Slope Borough
- $90 million to the State
- $125 to the Federal Government

This cumulative case is projected to generate additive employment and personal income increases as follows:

- 160 jobs annual average for North Slope Borough residents during development, declining to 40 during production. These include direct oil industry employment, indirect and induced employment.
- $10 million in total average annual personal income for workers residing in the North Slope Borough during development, declining to $2.8 million during production.
- 5,800 jobs annual average during development, declining to 3,300 during production. These jobs are for workers on the North Slope who reside in Southcentral Alaska and Fairbanks. These include direct oil industry employment and indirect and induced employment.
- $367 million in total average annual personal income for workers residing in Southcentral Alaska and Fairbanks during development, declining to $211 million during production.
- 5,800 jobs annual average during development, declining to 3,300 during production. These jobs are for workers who reside in the rest of the U.S. These include indirect and induced employment generated by expenditure for goods and services used on the North Slope and spending by direct employees.
- $367 million in total average annual personal income for workers residing in residing in the rest of the U.S. during development, declining to $211 million during production. This income is for indirect and induced workers generated by expenditure for goods and services used on the North Slope and spending by direct employees.
- 60-190 jobs for 6 months for cleanup of unlikely oil spills in the Beaufort Sea.

Contribution of Alternative I for Sale 186 to Cumulative Effects: Additive contributions of Sale 186 to the cumulative effect would be as follows:

- $1 million revenue average annually to the North Slope Borough annually for 22 years of production
- $27 million revenue average annually to the State for 22 years of production
- $57 million revenue average annually to the Federal Government for 22 years of production

- 40 jobs annual average for North Slope Borough residents during development declining to 9 during production. These include direct oil industry employment, indirect and induced employment
- $3.4 million in total average annual personal income for workers residing in the North Slope Borough development and declining to $0.7 million during production.
- 600 jobs annual average during development, declining to 390 during production. These jobs are for workers on the North Slope who reside in Southcentral Alaska and Fairbanks. These include direct oil-industry employment and indirect and induced employment.
- $38 million in total average annual personal income for production workers, declining to $25 million during production for these workers.
- 60-190 jobs for 6 months for cleanup of unlikely oil spills in the Beaufort Sea
- 10,000 jobs for 6 months for cleanup of an unlikely tanker spill in the Gulf of Alaska
- For a more complete analysis, see Section IV.C.10. Disruptions to harvesting of subsistence resources could affect the economic well-being of North Slope Borough residents mainly through the direct loss of some part of these resources. See Section V.C.11 for effects on subsistence-harvest patterns.

We anticipate no synergistic effects.

V.C.11. Subsistence Harvest Patterns

V.C.11.a. Cumulative Effects on Subsistence Harvest Patterns

Cumulative effects on subsistence-harvest patterns include effects from Alternative I for Sale 186 exploration and development and other past, present, and reasonably foreseeable projects on the North Slope (see Table V-7c). Alternative I for Sale 186 exploration and development itself could affect subsistence resources because of potential oil spills; noise and traffic disturbance; or disturbance from construction activities associated with ice roads, pipelines, and landfalls. Noise and traffic disturbance might come from building, installing, and operating production facilities and from supply efforts. See Section IV.C.11 Effects on Subsistence-Harvest Patterns for a more detailed discussion of effects on subsistence resources and harvest patterns.

To understand effects on subsistence-harvest patterns, we must recognize three major characteristics of North Slope communities: (1) they rely heavily on bowhead whales, caribou, and fish in the annual average harvest; (2) subsistence-hunting ranges overlap for many species harvested by Native communities; and (3) subsistence hunting and fishing are central cultural values in the Inupiat way of life. Chronic cumulative biological effects to subsistence resources would affect their harvests. Potential effects from oil spills and noise disturbance could affect (a) seal hunting during the winter; (b) whale, seal, bird, and caribou hunting in spring; and (c) whale, seal, bird, and caribou hunting during the open-water season.

Access to subsistence-hunting areas and subsistence resources, and the use of subsistence resources, could change if oil development reduces the availability of resources or alters their distribution patterns. Cumulative effects to bowhead whales is a serious concern. If increased noise affected whales and caused them to deflect from their normal migration route, they could be displaced from traditional hunting areas, and the traditional bowhead whale harvest could be adversely affected. Ideally, ongoing seismic operations are seasonally timed and monitored to minimize conflicts with the migration and the subsistence hunt. Drilling for Northstar development is being monitored to prevent conflicts with whales and whalers. Most projected reasonably foreseeable development projects are expected to be close to shore and away from traditional bowhead whale migration and harvest areas. In addition, although seismic and drilling noise from Alternative I for Sale 186 deepwater activities are projected and deflection of whales further offshore is possible, winter drilling and timing and siting concerns can normally be accommodated in a Conflict Avoidance Agreement between industry and whaling captains. Noise effects can be eliminated or substantially reduced by the coordination and location of seismic activities and offshore facility access and helicopter paths to minimize operations in the vicinity of migrating whales. Existing and proposed mitigation and eventual permit conditions for Alternative I for Sale 186 development and other future projects would examine the timing and monitoring of potential noise sources to prevent conflicts to whales and subsistence whalers.

If the unlikely event that a large oil spill occurred and affected any part of the bowhead whale's migration route, it could taint this culturally important resource. Any actual or perceived disruption of the bowhead-whale harvest from oil spills and any actual or perceived tainting anywhere during the bowhead's inmigration, summer feeding, and fall migration could disrupt the bowhead hunt for an entire season, even though whales still would be available. Tainting concerns also would apply to polar bears, seals, fish, and birds. Biological effects to subsistence resources may not affect species' distributions or populations, but disturbance could force hunters to make more frequent and longer trips to harvest enough resources in a given season. For beluga whales, more flexible hunting patterns may reduce the effects of noise and disturbance. Hunters can take belugas in ice leads and open water at different times for a 6-month period, and belugas are not the whale species preferred in potentially affected communities. In the unlikely event that a large oil spill occurred, it could cause potential short-term but significant adverse effects to long-tailed duck and king and common eider populations. Subsistence-bird resources could experience short-term, local disturbance, but such disturbance could cause waterfowl to avoid productive subsistence-hunting sites. For the spring subsistence-waterfowl harvest, cumulative loss of habitat from development activities and population losses from oil spills significantly could disrupt harvests. An onshore pipeline spill that contacted rivers and streams could kill many fish and affect these fish populations. A potential loss of polar bears from oil-spill effects could reduce their availability locally to subsistence users, although polar bears are most often hunted opportunistically by North Slope subsistence hunters while in pursuit of more-preferred subsistence resources.

Limited monitoring data prevent effective assessment of cumulative subsistence-resource damage; resource displacement; changes in hunter access to resources; increased competition; contamination levels in subsistence resources; harvest reductions; or increased effort, risk, and cost to hunters. We cannot project effects properly without monitoring harvest patterns and the effectiveness of mitigating measures, and any effective monitoring regime must include serious attention to traditional Inupiat knowledge of subsistence resources and practices. Development already has caused increased regulation of subsistence hunting, reduced access to hunting and fishing areas, altered habitat, and intensified competition from nonsubsistence hunters for fish and wildlife (Haynes and Pedersen, 1989; Pedersen et al., 2000). These trends show why it is vital to monitor subsistence resources and harvests.

Because oil development and the refounding of Nuiqsut essentially were simultaneous, passage of the Alaska Native Claims Settlement Act precipitated a resurgence of the community and its subsistence culture and, at the same time, allowed the Trans-Alaska Pipeline to be built—it is difficult to disaggregate the cumulative effects of oil development in the region from these relatively recent processes of extreme local social change. Proper assessment of cumulative effects on the North Slope is critical, but separating the effects of an oil-development project from those of general social change can be difficult.

V.C.11.a(1) Native Views Concerning Cumulative Effects on Subsistence Harvest Patterns

V.C.11.a(1)(a) Nuiqsut's Views on Cumulative Effects

Cumulative effects from oil development have been, and continue to be, paramount concerns for North Slope residents. Sam Taalak, Nuiqsut's Mayor in 1982, saw the onslaught of cumulative activity 18 years ago: "We presently live at Nuiqsut and for the moment we're hemmed in from all sides by major oil explorations, even from the coast front" (Taalak, 1983, as cited in USDOI, MMS, 1983a). Leonard Lampe, another former Mayor of Nuiqsut, noted that the village has begun to consider the long-term effect of oil development on their subsistence lifestyle and Inupiat culture: "It's time to look at things seriously and ask if it's worth it. That's what the town is asking itself" (Lavrakas, 1996).

Thomas Napageak, Nuiqsut Native Village President and Chairman of the Alaska Eskimo Whaling Commission, recently clarified some of these concerns. In a January 10, 1997, meeting with MMS in Anchorage over a possible Nuiqsut Deferral for Sale 170, Mr. Napageak explained that the people of Nuiqsut have begun to focus on cumulative effects because they are concerned that when the Northstar

Project proceeds, it will be out there and affecting the community and its ability to harvest subsistence resources for 15-20 years. Such development directly affects Nuiqsut. Mr. Napageak wanted Sale 170 stipulations to deal with cumulative effects from the sale, and from other projects, and clear language about cumulative effects in the EIS. He wanted to see protective language developed for leases in the Sale 170 area that would extend to, and bind lessees with, leases from past sales (Casey, 1997, pers. commun.).

At a scoping meeting in Nuiqsut for the Northeast National Petroleum Reserve-Alaska Integrated Activity Plan EIS, Mr. Napageak noted again the importance of assessing cumulative effects on subsistence resources and harvests, especially the cumulative and indirect effects of existing and potential oil development on Nuiqsut. He remarked, “Federal leasing cannot be examined in isolation as though none of this other development and potential development were going on” (USDOI, Bureau of Land Management, 1997a). At a Bureau of Land Management symposium on the National Petroleum Reserve-Alaska held later the same month, he reaffirmed this concern: “Accumulated impact effects that would hinder the community and the socioeconomics of the community, how it will be affected by Alpine and presumably by NPR-A, these...really need to be considered” (Napageak, as cited in USDOI, Bureau of Land Management, 1997b). At an information update meeting in November 1999 for the Liberty Development Project, Elders Ruth Nukapigak and Marjorie Ahnupkana reaffirmed local concern for ongoing effects from oil development, saying that Eskimo traditions of long ago were going away with the oil companies coming in (Ahnupkana, as cited in USDOI, MMS, Alaska OCS Region, 1999).

V.C.11.a(1)(b) Kaktovik’s Views on Cumulative Effects

Kaktovik resident Michael Jeffrey, testifying for the first MMS lease sale of offshore oil and gas, saw a social impact from government actions. He said there was a cumulative effect on the villagers from having to participate in hearings and meetings. People knew the issues were important, so they had to take time off from working and hunting to attend. Jeffrey believed assessment documents are too technical. To help villagers with them, he suggested extending deadlines in communities that do not speak English so there would be enough time for agencies to translate documents (Jeffrey, 1979, as cited in USDOI, Bureau of Land Management, 1979b).

V.C.11.a(1)(c) Barrow’s Views on Cumulative Effects

The North Slope Borough sent written scoping comments and recommendations on the Bureau of Land Management’s Northeast National Petroleum Reserve-Alaska Integrated Activity Plan in April 1997. Their comments articulated concerns about potential effects to subsistence hunting and “about the cumulative impacts of all industrial and human activities on the North Slope and its residents. Consideration of these impacts must take into account industrial activities occurring offshore and at existing oil fields to the east; scientific research efforts; sport hunting and recreational uses of lands; and the enforcement of regulations governing the harvest of fish and wildlife resources by local residents. To date, no agency has addressed the concerns of Borough residents over how cumulative impacts might affect life on the North Slope” (North Slope Borough, 1997). Barrow Mayor Ben Nageak, spoke at public hearings for the National Petroleum Reserve-Alaska Integrated Activity Plan EIS in Barrow in January 1997. He said one of the key issues in developing the Reserve was to identify “a mechanism for recognizing and mitigating the potential cumulative impacts of multiple industrial operations” (Nageak, as cited in USDOI, Bureau of Land Management, 1997b). At a Liberty Development Project information update meeting in November 1999, Ron Brower, head of the Inupiat Heritage Center in Barrow, asked about future leasing and development plans and noted that MMS seemed to be doing projects piece by piece when instead it should be studying cumulative impacts. He believed new data and new development projections were needed and wanted to see a “new blueprint [for development] from aerial flights to underwater impacts” (Brower, as cited in USDOI, MMS, 1998). At the same meeting, Maggie Ahmaogak, Executive Director of the Alaska Eskimo Whaling Commission, asked that MMS take into account cumulative risks.

V.C.11.a(1)(d) Chukchi Sea Communities’ Views on Cumulative Effects

Native bowhead and beluga whale hunters in communities in the Chukchi Sea region maintain that they, too, will be affected if important marine mammals are harmed. Just as in the Beaufort Sea communities of Barrow, Nuiqsut, and Kaktovik, the potential tainting of bowhead and beluga whales and seals, in any portion of their respective ranges and habitats, could taint these culturally important resources. Even if these species were available for the spring and fall seasons, traditional cultural concerns of tainting could make them less desirable and alter or stop subsistence harvests.

The following is a summary of effects of oil spills, disturbance, and habitat loss on subsistence resources.

V.C.11.a(2) Effects of Large Oil Spills and Disturbance on Subsistence Resources

V.C.11.a(2)(a) Bowhead Whales

Overall, exposure of bowhead whales to noise from oil and gas operations should not kill any bowhead whales, but some could experience temporary, nonlethal effects. Whales exposed to spilled oil likely would experience temporary, nonlethal effects, although prolonged exposure to freshly spilled oil could kill some whales. The incremental contribution of effects from Alternative I for Sale 186 to the overall effects under the cumulative case is not likely to cause an adverse effect on the bowhead whale population (Section IV.C.11.b(1)(b)1)).

V.C.11.a(2)(b) Seals and Polar Bears

The overall effects (mainly from one oil spill assumed for this analysis) is the potential losses of perhaps up to 30 polar bears, a few hundred to a few thousand seals and walruses, and probably fewer than 10 beluga and gray whales. In the likely cumulative case, seal, polar bear, and beluga and gray whale populations are expected to recover within 1 year, assuming only one large spill (greater than or equal to 1,000 barrels) occurs. Potential cumulative oil spills along the tanker route to the U.S. West Coast could have long-term (more than one generation or perhaps 5-10 years) effects on sea otters and perhaps harbor seals and other marine mammals. Cumulative noise and disturbance from Alternative I for Sale 186 is expected to briefly and locally disturb or displace a few seals, walrus, beluga whales, and polar bears. A few polar bears could be temporarily attracted to the production island with no significant effects on the population's distribution and abundance (Section IV.C.11.b(1) (b)2))

V.C.11.a(2)(c) Birds

Although the potential effects of spills are very uncertain, a large offshore oil spill could result in losses exceeding 10,000 individuals, primarily to waterfowl and shorebirds staging offshore in lagoons or along beaches, if the spill occurred during the breeding season. Overall cumulative effects of oil-industry activities on marine and coastal birds potentially could be substantial, primarily as a result of mortality from oil spills. Disturbance may cause loss of productivity and lowered survival of birds occupying areas with high levels of industry activity (Section IV.C.11.b(1)(b)5))

V.C.11.a(2)(d) Caribou and Other Terrestrial Mammals

Terrestrial mammals that would be affected include caribou, muskoxen, grizzly bears, and arctic foxes. Oil development in the Prudhoe Bay area could continue to displace some caribou during the calving season within about 2.5 miles of some roads with vehicle traffic that crosses calving habitat. The general shift of caribou calving away from the large oil fields may persist. Cows and calves of the Central Arctic Herd may, over time, reduce calving and the use of summer habitats near roads with high levels of traffic. If they do, these activities potentially could affect the caribou's productivity and abundance over the long term. However, this potential effect may not be measurable, because the caribou's productivity greatly varies under natural conditions. Some oil-development projects, such as Badami and Alpine, do not include roads constructed to Prudhoe Bay and the Dalton Highway. They are not likely to disturb or displace calving caribou or change caribou movements across the Arctic Slope. Cumulative oil development is likely to have only local effects on the distribution and abundance of caribou, muskoxen, grizzly bears, and arctic foxes on the North Slope of Alaska and not affect overall distribution and abundance. Potential cumulative oil spills along the tanker route to the U.S. West Coast could have short-term (1-3 years) effects on other terrestrial mammals (Section IV.C.11.b(1)(b)3))

V.C.11.a(2)(e) Fishes

In general, marine and migratory fish populations are not measurably affected by the type of disturbances generated by oil- and gas-related activities. The wide distribution and low density of fish, the short-term and mild nature of their response to noise associated with oil and gas activities, and the wide distribution and low density of expected oil and gas projects is the basis for this conclusion. Some overwintering fish may not be able to avoid noise and disturbances and may be adversely affected. However, this is not likely to occur often, and most fish would be unaffected. Because water used for construction is not expected to be withdrawn from waters supporting fish, the use of freshwater for ice-road and pad construction is not expected to have a measurable cumulative effect on fish populations. Hence, disturbances associated with Alternative I for Sale 186 are not expected to contribute measurably to the overall cumulative effect on fishes.

According to Table V-12, the most likely number of oil spills (greater than 1,000 barrels) that would be contributed by Alternative I for Sale 186 is zero. Nevertheless, if a large oil spill occurred, small numbers of fish in the immediate area might be killed or harmed, if they were somehow trapped and unable to avoid it. However, marine and migratory fishes are widely distributed in the Beaufort Sea, most are not likely to become trapped, and most are not likely to be affected by an oil spill. Those that are in the vicinity of a large oil spill and are affected by it are likely to experience effects ranging from minor and short-term to no effect at all. For these reasons, oil spills associated with Alternative I for Sale 186 are not likely to have a measurable additive effect on fish populations (Section V.C.6).

V.C.11.a(3) Cumulative Effects on Habitat

Development has directly covered about 7,000 acres through the construction of 350 miles of roads, 89 pads, 4 airstrips, and 14 gravel mines (Table V-3). The mines cover more than 1,500 acres. Development in the Prudhoe Bay and Kuparuk areas has directly affected about 9,500 acres because of gravel excavation and filling, and indirectly affects many adjacent acres of vegetation. The total affected acreage is a small part of the Arctic Coastal Plain, and cumulative effects probably are not significant to the overall productivity of tundra plants in this area. It is important to remember that ongoing oil-development projects, such as Alpine, Badami, and Northstar, require a much smaller acreage footprint than existing and past projects on the North Slope.

Alterations from offshore production platform-island construction, trench-dredging, and pipeline burial are expected to affect some benthic organisms and some fish species within 1 kilometer for less than 1 year or season. These activities also temporarily may affect the availability of some local food sources for these species up to 1-3 kilometers (0.62-1.9 miles) distance during island construction, but these activities are not expected to affect food availability for seals over the long term. The effect of onshore-facilities siting—dust fallout, thermokarst, and hydrologic change—for future projects on bird populations, though additive, would be significantly less severe, because they would be restricted to much smaller areas and result in smaller habitat loss. Pads, gravel quarries, pipelines, pump stations, and gravel roads that cross much of the Central Arctic Herd’s calving range actually have destroyed only about 3-4% of the tundra grazing habitat for caribou.

If roads on the North Slope are opened to the public, there would be an increase in access to caribou herds, muskoxen, grizzly bears, and other terrestrial mammals, potentially leading to more hunting and disturbance. Increased access increases competition for resources—a potential negative impact on subsistence hunters. Furthermore, more roads usually means reduced access (or increased effort) for subsistence hunters. New roads are obstacles to traveling to traditional hunting areas because of security protocols imposed on access roads to and in development areas. Roads and pipelines force hunters to travel farther to hunt or force them to hunt in nontraditional areas.

V.C.11.b Transportation Effects on Subsistence Harvest Patterns

V.C.11.b(1) Small Onshore Spills from the Trans-Alaska Pipeline System

Considering the small additive effects of onshore oil spills from the Trans-Alaska Pipeline System on individual subsistence resources, measurable cumulative effects on subsistence harvests are not expected.

Small onshore spills, whether originating from field pipelines or from the Trans-Alaska Pipeline System would have a very small additive effect on terrestrial mammal habitats near pipelines, roads, and other facilities. Small spills are expected to be cleaned up before substantial losses occur and cleanup at the spill site would frighten caribou and other terrestrial mammals away from the spill and prevent contact with the oil. Small spills are not expected to significantly affect bird species occurring in the Beaufort Sea region. In winter, onshore pipeline spills on the North Slope and along the Trans-Alaska Pipeline System would not be expected to affect fish, because their likelihood of contacting fish habitat is very low. In summer, fish and food resources in a small waterbody with restricted water exchange likely would be harmed or killed from a small spill of sufficient size. Recovery would be expected in 5-7 years. Small numbers of fish in the immediate area of an onshore oil spill may be killed or harmed, but small oil spills would not be expected to have measurable cumulative effects on fish populations. The additive effect of small onshore spills would cause minor ecological harm to wetlands and vegetation that should recover within a few years but could take more than 20 years. Most onshore spills occur on gravel pads, and their effects do not reach surrounding vegetation. About 20-35% of past crude oil spills has reached areas beyond pads. Because winter spans most of the year, about 60% of the time spills occur when workers can clean up oil on the snow cover before it reaches the vegetation.

V.C.11.b(2) Large Tanker Spill in the Gulf of Alaska

Alternative I for Sale 186 is not expected to contribute any tanker spills to the cumulative analysis—the mean number of spills is 0.41 (see Table V-12). However, potential future oil-spill effects from tanker transportation of arctic oil, including oil from Alternative I for Sale 186, from the Trans-Alaska Pipeline System terminal in Valdez could produce local cumulative effects. Using experience from the *Exxon Valdez* spill as a gauge, a 250,000-barrel oil spill substantially could reduce or alter subsistence harvests for the residents of Cordova and Yakutat. In Cordova, especially for intertidal resources and some fish species, effects could be experienced for at least 4 years. Lesser effects of shorter duration could be expected for Yakutat. The instantaneous nature of the event would not permit opportunistic “stocking up” of available resources.

V.C.11.b(3) Potential Effects of Transporting Arctic Oil from the Trans-Alaska Pipeline System

Oil produced from Alternative I for Sale 186 is expected to contribute about 7%; the most likely number of spills is zero spills from Trans-Alaska Pipeline System tankers. In Alaskan waters, the probable oil-tanker route lies seaward of the 200-mile Economic Exclusion Zone boundary except in the northcentral Gulf of Alaska, where the transportation route leaves Prince William Sound. Oil spilled along most of this route would tend to move parallel to the Alaska Peninsula and the Aleutian Islands, rather than towards the coast, where vulnerable resource populations could be contacted. Oil spilled from a tanker after exiting Prince William Sound could contact the Kodiak and Alaska Peninsula areas.

A large oil spill, future tanker spills of arctic oil, which may include Alternative I for Sale 186 oil, could cause serious and long-term cumulative effects on some subsistence resources in Prince William Sound and the Gulf of Alaska, especially marine and coastal birds, sea otters, and harbor seals, with lesser effects on river otters and brown and black bears. An economic loss for 2 years following the spill to the commercial-fishing industry in this area would range from 37-64% per year and also would represent a serious loss to the subsistence fishery. (See Sections V.C.1 on threatened and endangered species; V.C.2 on seals and polar bears; V.C.3 on marine and coastal birds; V.C.4 on terrestrial mammals; and V.C.6 on fishes.)

A realistic projection of the occurrence of a tanker spill calculated from tanker spill records indicates most spills (7 of 10) are expected to average 6,000 barrels or less. We estimate 11 spills with an average size of 6,000 barrels, 1 of which occurs in port and 10 at sea. We assume two spills with an average size of 13,000 barrels, both which occur at sea, and one spill at sea in the Gulf of Alaska at 200,000 barrels (see Table V-15). One of these spills would occur in ports where contingencies for cleanup and containment are in place, contributing to relatively quick containment and cleanup of these in-port spills. Spills of this size at sea have not been found to cause serious effects on bird, fish, and sea mammal populations when the effects have been studied. Additionally, at-sea spills of these average sizes are not expected to reach large areas of habitat critical to these species’ survival until after the oil has been rendered less harmful by weathering and dispersion in the water. Recovery periods would be lengthened, if more than one spill affected the same population within a short interval—an unlikely situation. Therefore, effects on species along the tanker-transportation route south of the Gulf of Alaska to West Coast and California ports are expected to be about the same or less than those described here, keeping in mind that there are few and limited subsistence harvests of any species along this corridor outside of Alaska. The potential for an oil spill to affect subsistence fisheries, particularly salmon, in the Pacific Northwest (see Section V.C.1, Threatened and Endangered Species) and the small subsistence gray whale hunt of the Makah tribe on the Washington coast along the tankering corridor, appears to be limited.

LaBelle and Marshall (1995) calculated simulated oil-spill trajectories for tanker routes off the U.S. West Coast. Oil-spill trajectories were mapped as "risk contours" (or oil-spill travel time at sea), showing the chance of contact to environmental resource areas, assuming an oil spill occurred (conditional probabilities). Off the California coast, an oil spill at 100 nautical miles offshore would have a 5% chance of contacting the shoreline within 30 days, while an oil spill at 80 nautical miles offshore would have a 10% chance of contacting the shoreline within 30 days. The contour lines are farther offshore off Washington and Oregon.

Summary and Conclusion for Beaufort Sea, North Slope, and Transportation Activities on Subsistence-Harvest Patterns: Access to subsistence-hunting areas and subsistence resources, and the use of subsistence resources could change, if oil development reduces the availability of resources or alters their distribution patterns. The most serious concern to North Slope Inupiat is that potential increases in noise from cumulative oil development could disrupt the normal migration of bowhead whales, forcing subsistence whalers into longer hunts farther from shore. This issue has been voiced many times over many years. Recently, Eugene Brower, President of the Barrow Whaling Captains' Association, articulated the issue in a statement he made at the January 6, 2000, meeting of the MMS Regional Offshore Advisory Committee:

> I have the responsibility of talking on behalf of my whaling captains in Barrow. There's 44 captains with 550 plus crew members that have great concern for the lease sales…the area of concern that we're talking about is the whole migration route of the bowhead whale. What goes on in the eastern portion of the Canadian Border all the way through Barrow impacts three villages. [For] their livelihood, we have a great concern…The concern is always the same…but what impacts Kaktovik impacts Barrow and Nuiqsut in the middle. Anything that goes [on] in the east impacts us all the way to Barrow. And I, for one, would never want to see a permanent structure out in the open sea because of the experience we had from…one little platform off Cooper Island, five miles offshore. It was stationary, just idling. Just the noise being emitted from that structure was enough to divert the bowhead whales further out. There was nothing in between the structure and the mainland, 9 miles of water in between them but nothing went through. It was always on the outside. So if you're going to be putting permanent facilities out in the water on the Beaufort Sea, it's going to be making a lot of noise with the gravel pad, whatever structure you put out there. It's going to impact our livelihood (USDOI, MMS, 2000).

In the unlikely event that a large oil spill occurred and affected any part of the bowhead whale's migration route, it could taint this culturally important resource. Any actual or perceived disruption of the bowhead-whale harvest from oil spills and any actual or perceived tainting anywhere during the bowhead's migration, summer feeding, and outmigration could disrupt the bowhead hunt for an entire season, even though whales still would be available. In fact, even if whales were available for the spring and fall seasons, traditional cultural concerns of tainting could make bowheads less desirable and alter or stop the subsistence harvest in Barrow, Nuiqsut and Kaktovik for up to two seasons. Concerns over the safety of subsistence foods could persist for many years past any actual harvest disruption. This would be a significant adverse effect. In terms of other species, this same concern also would extend to polar bears and seals. Native harvests of bowhead and beluga whales by subsistence hunters in the Chukchi Sea region also would be affected by tainting concerns. From Alternative I for Sale 186 exploration and development alone, in the unlikely event that a large oil spill occurred, other subsistence resources, as well, could be periodically affected in the communities of Barrow, Nuiqsut, and Kaktovik.

Additionally, in the unlikely event that a large oil spill occurred, potential short-term but significant adverse effects to long-tailed ducks and king and common eider populations; a large onshore pipeline spill that contacted the Sagavanirktok River or East Sagavanirktok Creek could kill many fishes and affect these fish populations. A potential loss of polar bears from oil-spill effects could reduce their availability locally to subsistence users although they are seldom hunted by subsistence hunters except opportunistically while in pursuit of more preferred subsistence resources. More roads on the North Slope increase non-Native access to, competition for, and disturbance of resources—a potential negative impact on subsistence hunters. More roads usually mean reduced access or increased effort for subsistence hunters, because new roads bring new access and security restrictions imposed by the oil industry. This forces hunters to travel farther to hunt or forces them to hunt in nontraditional areas.

Ongoing tanker transportation of oil from Valdez to the West Coast could cause serious and long-term cumulative effects on some subsistence resources in Prince William Sound and the Gulf of Alaska, especially on marine and coastal birds, sea otters, and harbor seals, with lesser effects on river otters and brown and black bears. Economic losses could be expected for 2 years to the commercial-fishing industry, and a serious loss to the subsistence fishery also would be expected. Effects on species along the tanker-transportation route south of the Gulf of Alaska to West Coast and California ports are expected to be about the same or less than those described above because there are few and limited subsistence harvests of any species along this corridor outside of Alaska. The threat of an oil spill to subsistence fisheries, particularly salmon, in the Pacific Northwest and the small subsistence gray whale hunt of the Makah tribe on the Washington Coast along the tankering corridor appears to be limited.

Conclusion: Cumulative effects on subsistence-harvest patterns include effects from Alternative I for Sale 186 exploration and development and other past, present, and reasonably foreseeable projects on the North Slope with one or more important subsistence resources becoming unavailable or undesirable for use for 1-2 years, a significant adverse effect Sources that could affect subsistence resources include potential oil spills, noise and traffic disturbance, and disturbance from construction activities associated with ice roads, production facilities, pipelines, gravel mining, and supply efforts. The communities of Barrow, Nuiqsut, and Kaktovik would potentially be most affected, with Nuiqsut potential being the most affected community because it is within an expanding area of oil exploration and development both onshore (Alpine and the Northeast National Petroleum Reserve-Alaska) and offshore (Northstar and McCovey). In the unlikely event that a large oil spill occurred and contaminated essential whaling areas, major additive significant effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Because the likelihood of a large oil spill is unlikely, attaining a level of significant effect also is unlikely. The placement of a drilling structure or production island near the bowhead whale migration corridor that operated over the life of a field (15-20 years) would represent a far more significant effect because of potential long-term noise disturbance to migrating whales. We expect that mitigation would be developed to prevent any long-term disruption to migrating whales from industrial noise. No synergistic effects are expected.

Contribution of the Alternative I for Sale 186 to Cumulative Effects: Alternative I for Sale 186, represents a small proportion 7% of the total past, present, and reasonably foreseeable oil and gas development in the Beaufort Sea area. While the most likely number of oil spills greater than or equal to 500 barrels from all past, present, and future activities onshore is estimated to be 5, the most likely number of offshore spills is estimated to be zero. The Alternative I for Sale 186 is estimated to contribute about 18% of the estimated mean number of cumulative offshore spills, with a most likely number of spills of 0 (Table V-12).

In the unlikely event of a spill from Alternative I for Sale 186, many harvest areas and some subsistence resources would be unavailable for use. Some resource populations could suffer losses and, as a result of tainting, bowhead whales could be rendered unavailable for use. Tainting concerns in communities nearest the spill event could seriously curtail traditional practices for harvesting, sharing, and processing bowheads, threatening a critical underpinning of Inupiat culture. Whaling communities distant from and unaffected by potential spill effects are likely to share bowhead whale products with impacted villages. Harvesting, sharing, and processing of other subsistence resources should continue but would be hampered to the degree that these resources were contaminated.

V.C.12. Sociocultural Systems

V.C.12.a. Details of Cumulative Effects on Sociocultural Systems

Cumulative effects on sociocultural systems include effects of Alternative I for Sale 186 exploration development and other past, present, and reasonably foreseeable projects on the North Slope (Tables V-3, V-5, and V-6a). Cumulative effects on sociocultural systems would come from changes to subsistence-harvest patterns, social organization and values, and other issues, such as stress on social systems (see Impact Assessment Inc., 1990a,b,c; 1998; Human Relations Area Files, Inc., 1995; State of Alaska, Dept. of Fish and Game, 1995b).

V.C.12.a(1) Social Organization

In this cumulative analysis, effects on social systems could result from industrial activities, changes in population and employment, and changes in subsistence-harvest patterns. These effects would be similar to those described in Section IV.C under Effects Common to All Alternatives, but the level of effects would increase because collectively, activities would be more intense. More air traffic and non-Natives in the North Slope region could increase the interaction and, perhaps, conflicts with Native residents. In the past, non-Native workers have stayed in enclaves, which kept interactions down. However, recent activity in the Alpine field has brought non-Natives directly into the Native village of Nuiqsut, and this has added stresses in the community. Already, these workers have made demands on the village for more electrical power and health care. This potential remains for the communities of Barrow and Kaktovik.

Increases in population growth and employment could cause long-term disruptions to (1) the kinship networks that organize the Inupiat communities' subsistence production and consumption, (2) extended families, and (3) informally derived systems of respect and authority (mainly respect of elders and other leaders in the community). Offsetting such effects are strong efforts by the North Slope Borough, the Alaska Eskimo Whaling Commission, regional and tribal governments, local governments, and village corporations to institutionally foster and protect Inupiat cultural traditions. Cumulative effects on subsistence-harvest patterns (which also would be long term) would affect Inupiat social organization through disruptions to kinship ties, sharing networks, task groups, crew structures, and other social bonds. Effects on sharing networks and subsistence-task groups could break down family ties and the communities' well-being, creating tensions and anxieties that could lead to high levels of social discord. The North Slope Borough, the Alaska Eskimo Whaling Commission, and local whalers have set precedents for negotiating agreements with the oil industry to protect subsistence-whaling practices. Such cooperation is expected to continue. Negotiated agreements exist for development effects onshore at the Alpine Unit north of Nuiqsut. The Bureau of Land Management has convened a Subsistence Advisory Panel for the Northeast National Petroleum Reserve-Alaska Integrated Activity Plan/EIS planning. It consists of Bureau of Land Management officials and tribal members from local communities. This group is tasked with investigating conflicts between subsistence activities and oil exploration and development, verifying the levels of conflict, and proposing resolutions to the lessee and the Bureau of Land Management. It is too soon to know how effective this panel will be in resolving such conflicts.

V.C.12.a(2) Cultural Values

Cumulative effects on cultural values also could result from industrial activities, changes in population and employment, and changes in subsistence-harvest patterns. These effects would be similar to those described in Section IV.C under Effects Common to All Alternatives for Alternative I for Sale 186 exploration and development, but at higher levels. Cumulative effects on social organization could include decreasing importance of the family, cooperation, sharing, and subsistence as a livelihood, and increasing individualism, wage labor, and entrepreneurship. Long-term effects on subsistence-harvest patterns also would be expected. Chronic disruption could affect subsistence task groups and displace sharing networks, but it would not displace subsistence as a cultural value. Sociocultural cumulative effects of changing norms and values would be expected to affect all five social institutions (family, polity, economics, religion, and education), but the North Slope Borough's institutional infrastructure, the Alaska Eskimo

Whaling Commission, community whaling organizations, regional and tribal governments, and regional and village corporations work diligently to develop programs to protect these cultural values (Impact Assessment Inc., 1990a,b,c, 1998; Human Relations Area Files, Inc., 1995; State of Alaska, Dept. of Fish and Game, 1995b).

V.C.12.a(3) Other Issues

Stress created by the fear of an oil spill also is a distinct predevelopment impact-producing agent within the human environment. Stress from this general fear can be broken down to the particular fears of:

- being inundated during cleanup with outsiders who could disrupt local cultural continuity;
- the damage that spills would do to the present and future natural environment;
- drawn out oil-spill litigation;
- contamination of subsistence foods;
- the lack of local resources to mobilize for advocacy and activism with regional, State, and Federal Agencies;
- the lack of personal and professional time to interact with regional, State, and Federal agencies;
- retracing the steps (and the frustrations involved) taken to oppose offshore development;
- responding repeatedly to questions and information requests posed by researchers and regional, State, and Federal outreach staff; and
- needing to employ and work with lawyers to draft litigation to attempt to stop proposed development.

A State of Alaska Department of Fish and Game social-effects survey administered by the Division of Subsistence Management in 1994 in Nuiqsut included questions on effects from outer continental shelf development. Sixty-percent of the respondents did not believe a small oil spill could be contained or cleaned up, and 80% did not believe a large oil spill could be contained or cleaned up. The overall study on 21 Alaskan communities concluded that impacts persist from the *Exxon Valdez* oil spill on subsistence use and the social and cultural system that subsistence activities support (Fall and Utermohle, 1995; Impact Assessment, Inc., 1998; Field et al., 1999).

For this cumulative analysis, we may see increases in social problems, such as rising rates of alcoholism and drug abuse, domestic violence, wife and child abuse, rape, homicide, and suicide. The North Slope Borough already is experiencing problems in the social health and well-being of its communities, and additional development (including offshore oil development) on the North Slope would disrupt them further. Historically, more income in these communities has connected somewhat to the abuse of alcohol and increased violence. Sources show increases in dysfunctional behavior during the peak of the commercial-whaling era and then again during the height of the fur trade. Drinking and violence seem to ebb when increases decline. Recent evidence of the effects of employment during and just after World War II loosely supports these views. Although this evidence is not clear, it can still be assumed that onshore oil development has resulted in large cash flows that have lead to significant social changes. These social changes on the North Slope are likely to have influenced the extremely high rate of suicide among the Inupiat (90.8 per 100,000 for the Inupiat versus 35 per 100,000 among the Yup'ik [Travis, 1989]).

The relationship of oil and gas development to aberrant behavior and social pathologies might be seen more clearly in terms of social change and associations rather than in direct causality. Oil and gas development has affected all communities in Alaska and, for this reason, finding control communities is difficult; yet these impacts to communities are important to understand, and more cumulative-effects studies need to be conducted. In a general sense, the cumulation of effect occurs as modernization occurs. As change happens, these alterations spread through the social fabric. Such change can be both negative and positive and can be measured to an extent with objective indicators of the opportunity structure or the stratification system such as education, income, occupation, social networks, and social mobility (created through income, education, etc.) (Cluck, 2000, pers. commun.).

Within this change, produced by the trends of modernization, the "rational choice" of individuals being affected by this change must be considered. Individuals make decisions, sometimes negative, sometimes positive, and stress or fear of change can reinforce a situation of internal conflict that can lead to negative social pathological effects. At the same time, positive impacts may come from higher incomes (that can purchase better equipment for subsistence), better health care, and improved educational facilities. Yet what may be seen on the surface as having positive impacts may, at the same time, produce negative effects by producing apathy to or disinterest in older cultural norms known as anomie. An example of this is an increased used of the Internet versus a reduction in listening to elders. Certain negative effects from social change are inescapable. As technology and opportunity develop, younger individuals readily accept these changes. This is seen easily in less developed countries where rapid change is evident or in the desertion of rural America by young people (Cluck, 2000, pers. commun.).

Both positive and negative impacts from oil and gas development exist in the North Slope Borough. Whether they are the more positive ones of increased funding for infrastructure or education or more negative ones associated with a lack of interest by younger people in traditional ways, both have added to social change. Oil and gas development has been one catalyst for such cumulative change on the North Slope; it needs further study, but it is not the single causal agent (Cluck, 2000, pers. commun.).

In the cumulative case, long-term effects could displace social systems; however, the North Slope Borough is vigilantly protecting the rights and culture of the Inupiat. Health and social services programs have tried to respond to alcohol and drug problems with treatment programs and shelters for wives and families of abusive spouses, in addition to providing greater emphasis on recreational programs and services. These programs, however, sometimes do not have enough money, and North Slope Borough city governments cannot help as much now that they get less money from the State. Partnering together, tribal, city, and the Borough governments may be able to provide programs, services, and benefits to residents. All communities in the North Slope Borough have banned the sale of alcohol for many years, but the possession of alcohol is not banned in Barrow, and many communities are continually under pressure to bring the issue up for a local referendum (North Slope Borough, 1998).

V.C.12.a(4) Effects of Oil-Spill Cleanup on Social Systems

In the unlikely event that a large oil spill occurred, cleanup activities for the one estimated offshore spill greater than or equal to 1,000 barrels occurring over the life of the field and elsewhere could generate many cleanup and response jobs. Based on the *Exxon Valdez* spill, Native residents employed in cleanup work could stop participating in subsistence activities, have a lot of money to spend, and tend not to continue working in other lower paying community jobs. In the event of a much larger spill event, these dramatic changes could cause tremendous social upheaval (Human Relations Area Files, Inc., 1995; State of Alaska, Dept. of Fish and Game, 1995b; Impact Assessment, Inc., 1990c, 1998). Many North Slope village men have been trained in cleanup procedures and have said they want to be part of any cleanup response (Lampe, 1999). The North Slope Borough would play a large part in structuring any spill response and cleanup (*North Slope Subarea Contingency Plan*, Environmental Protection Agency, U.S. Coast Guard, and State of Alaska, Dept. of Environmental Conservation, 1999).

V.C.12.b. Transportation Effects on Sociocultural Systems

V.C.12.b(1) Large Tanker Spill in the Gulf of Alaska

Sociocultural systems in the community of Cordova could undergo severe individual, social, and institutional stress and disruption from a 250,000-barrel spill (Section IV.I), which would last at least 4 years. Lesser effects of shorter duration could be expected for Yakutat. Individuals and the community of Cordova that depend on income from commercial fisheries could experience stress and anxiety from debt burden, income shortfalls, litigation, and fear for the future, should the fisheries they participate in or depend on in other capacities be shortened or terminated because of the accidental spill. Considerable stress and anxiety also would be expected over the loss of subsistence resources, contamination of habitat, fear of the health effects of eating contaminated wild foods, and the need to depend on the knowledge of others about environmental contamination (Fall, 1992; McMullen, 1993). Individuals and the community of Cordova would be increasingly stressed during the time needed to modify subsistence-harvest patterns by selectively changing harvest areas, if such areas were even available. Associated culturally significant activities, such as the organization of subsistence activities among kinship and friendship groups and the relationships among those that customarily process and share subsistence harvests, also would be modified or would decline.

A 250,000-barrel-spill also would be expected to affect individuals and social systems in ways similar to the experience from the *Exxon Valdez* spill. As shown by that spill, some individuals found a new arena for pre-existing personal and political conflict, especially over the dispensation of money and contracts. In the smaller communities, cleanup work produced a redistribution of resources, creating new schisms in the community (Richards, No date). Many members of small communities were on the road to sobriety before the spill; after the spill, some people began drinking again, producing the re-emergence of numerous alcohol-related problems, such as child abuse, domestic violence, and accidents (Richards, No date). Institutional effects included additional burdens being placed on local government, disruption of existing community plans and programs, strain on local officials, difficulties dealing with the spiller, community conflict, disruptions of customary habits and patterns of behavior, emotional effects and stress-related disorders, confronting environmental degradation and death, and the violation of community values (Endter-Wada, 1992). Postspill stress resulted from this seeming loss of control over individual and institutional environments as well as from secondary episodes such as litigation, which produced secrecy over information, uncertainty over outcomes, and community segmentation (Smythe, 1990; Picou and Gill, 1993). Attempts to mitigate effects met with a higher priority placed on concerns over litigation and a reluctance to intervene with people for fear it might benefit adversaries in legal battles (Richards, No date; Human Relations Area Files, Inc., 1995; State of Alaska, Dept. of Fish and Game, 1995b; Impact Assessment, Inc., 1990c, 1998).

V.C.12.b(2) Potential Effects of Transporting Arctic Oil from the Trans-Alaska Pipeline System

Oil produced from Alternative I for Sale 186 is expected to contribute about 7%; the most likely number of spills is zero spills from Trans-Alaska Pipeline System tankers. In Alaskan waters, the probable oil-tanker route lies seaward of the 200-mile Economic Exclusion Zone boundary except in the northcentral Gulf of Alaska, where the transportation route leaves Prince William Sound. Oil spilled along most of this route would tend to move parallel to the Alaska Peninsula and the Aleutian Islands, rather than towards the coast, where vulnerable resource populations could be contacted. Oil spilled from a tanker after exiting Prince William Sound could contact the Kodiak and Alaska Peninsula areas.

Based on the assumptions discussed in Section IV.I for a large oil spill, future tanker spills of arctic oil, which may include Alternative I for Sale 186 oil, could cause serious and long-term cumulative effects on some subsistence resources in Prince William Sound and the Gulf of Alaska, an economic loss for 2 years following the spill to the commercial-fishing industry that would range from 37-64% per year that would also represent a serious loss to the subsistence fishery (see Section V.C.11- Subsistence-Harvest Patterns).

A realistic projection of the occurrence of a tanker spill calculated from tanker spill records indicates most spills (7 of 10) are expected to average 6,000 barrels or less. We estimate 11 spills with an average size of 6,000 barrels, 1 of which occurs in port and 10 at sea. We assume 2 spills with an average size of 13,000 barrels, both which occur at sea, and 1 spill at sea in the Gulf of Alaska at 200,000 barrels (see Table V-15). One of these spills would occur in ports where cleanup and containment contingencies are in place, contributing to relatively quick containment and cleanup of these in-port spills. For this reason, effects on sociocultural systems along the tanker-transportation route south of the Gulf of Alaska to West Coast and California ports are expected to be reduced from those described above and in Section V.C.11.b(3) primarily because Native subsistence cultures south of Alaska have historically been marginalized by the dominant culture, and there are few Native communities that continue to practice a subsistence way of life. Other potential sociocultural effects not related to Native subsistence cultures are described in the following text.

V.C.12.b(3) Potential Effects on Recreation and Tourism Along the Transportation Route

A 200,000-barrel oil spill would preclude recreation and tourism activities in the coastal areas of the Wrangell-Saint Elias National Park and Preserve, the northern portion of the Tongass National Forest, and portions of Prince William Sound until spill-cleanup operations and natural processes restored the sites. Major economic losses could be expected for the tourist industry in the affected areas following a spill, with small charter boat, lodge, and sportfishing operations in the Yakutat and Cordova being the hardest hit. Tourist levels would be expected to rebound to prespill levels 1 year after the spill.

In the unlikely event of a large spill, effects on recreation and tourism along the tanker transportation route south of the Gulf of Alaska to West Coast and California ports could affect the same tourist industries and resources identified above. In coastal areas to the south, marine sanctuaries, shoreside beaches, parks, campgrounds, and recreation areas are more numerous and see more overall visitation. For this reason, economic losses to tourism could be greater. Public perceptions about the desirability of an area could change drastically after a spill event, and visitation could take longer to rebound. A recent agreement between The United Nations' International Maritime Organization and the U.S. Department of Commerce has set the shipping lanes for tankers 25-30 miles offshore of the Monterey Bay, Gulf of the Farallones, and Channel Islands National Marine Sanctuaries, affording these areas greater protection from vessel collisions, groundings, and spills. (CNN.com, 2000).

For tanker routes off the West Coast, simulated oil-spill trajectories were calculated by LaBelle and Marshall in 1995. Oil-spill trajectories were mapped as "risk contours" showing the chance of contact to environmental resource areas over time (3-, 10-, and 30-day travel times at sea) assuming an oil spill occurred (conditional probabilities). An oil spill at 100 nautical miles off the California coast would have a 5% chance of contacting the shoreline within 30 days, while an oil spill at 80 nautical miles offshore would have a 10% chance of contacting the shoreline within 30 days. For Washington and Oregon, the contour lines are farther offshore, and it is important to remember that tankers carrying oil from Alaska are from 100-200 miles offshore except when entering a port.

Summary and Conclusion for Beaufort Sea, North Slope, and Transportation Activities on Sociocultural Systems: In this cumulative analysis, effects on social institutions (family, polity, economics, education, and religion) could result from industrial activities, changes in population and employment, and changes in subsistence-harvest patterns. These effects would be similar to those described in Section IV.C under Effects Common to All Alternatives, but the level of effects would increase because collectively, activities would be more intense. More air traffic and non-Natives in the North Slope region could increase interaction and, perhaps, conflicts with Native residents. In the past, non-Native workers have stayed in enclaves, which kept interactions down. However, recent activity in the Alpine field has brought non-Natives directly into the Native village of Nuiqsut, and this has added stresses in the community. Already, these workers have made demands on the village for more electrical power and health care. This potential remains for the communities of Barrow and Kaktovik.

Increases in population growth and employment could cause long-term disruptions to (1) the kinship networks that organize the Inupiat communities' subsistence production and consumption, (2) extended families, and (3) informally derived systems of respect and authority (mainly respect of elders and other leaders in the community). Cumulative effects on social organization could include decreasing importance of the family, cooperation, sharing, and subsistence as a livelihood, and increasing individualism, wage labor, and entrepreneurship. Long-term effects on subsistence-harvest patterns also could be expected. Chronic disruption could affect subsistence-task groups and displace sharing networks, but it would not tend to displace subsistence as a cultural value.

At the same time, revenues from North Slope Borough taxation on oil development produce positive cumulative impacts that include increased funding for infrastructure, higher incomes (that can be used to purchase better equipment for subsistence), better health care, and improved educational facilities. We may see increases in social problems, such as rising rates of alcoholism and drug abuse, domestic violence, wife and child abuse, rape, homicide, and suicide. The North Slope Borough already is experiencing problems in the social health and well-being of its communities, and additional development, including offshore oil development on the North Slope, would further disrupt them. Health and social-services' programs have tried to respond to alcohol and drug problems with treatment programs and shelters for wives and families of abusive spouses, in addition to providing greater emphasis on recreational programs and services. These programs, however, sometimes do not have enough money, and North Slope Borough city governments cannot help as much now that they get less money from the State. Based on experiences after the *Exxon Valdez* spill, Native residents employed in cleanup work could stop participating in subsistence activities, have a lot of money to spend, and tend not to continue working in other lower paying community jobs. Because Nuiqsut is relatively close to oil development activities on the North Slope, cumulative effects chronically could disrupt sociocultural systems in the community—a significant effect; however, overall effects from these sources are not expected to displace ongoing sociocultural systems, community activities, and traditional practices for harvesting, sharing, and processing subsistence resources. This potential exists for the communities of Barrow and Kaktovik as Beaufort Sea areawide leasing, exploration, and development proceed on- and offshore. In the unlikely event that a large oil spill occurred and contaminated essential whaling areas, major additive (but not synergistic) effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together.

Future transportation of North Slope oil through Prince William Sound could produce cumulative effects on sociocultural systems from the effects of a large spill assumed, for purposes of analysis, to be 200,000 barrels. As a result, the communities of Yakutat and Cordova likely would undergo severe individual, social, and institutional stress and disruption that would last for at least 4 years. Sociocultural effects south of the Gulf of Alaska to U.S. West Coast and California ports are expected to be reduced from those described above, primarily because Native subsistence cultures south of Alaska historically have been marginalized by the dominant culture, and there are few Native communities that continue to practice a subsistence way of life. Effects to recreation and tourism would be major economic losses for the tourist industry, with small charter boat, lodge, and sportfishing operations in the Yakutat area being the hardest hit. Tourist levels would be expected to rebound to prespill levels 1 year after the spill. Recreation and tourism effects south of the Gulf of Alaska to West Coast and California ports would affect the same tourist industries and resources; however, in coastal areas to the south, marine sanctuaries, shoreside beaches, parks, campgrounds, and recreation areas are more numerous and see more overall visitation. For this reason, economic losses from tourism losses could be greater.

Contribution of Alternative I for Sale 186 to Cumulative Effects: The contribution from Alternative I for Sale 186 to cumulative effects on the sociocultural systems of the communities of Barrow, Nuiqsut and Kaktovik could come from disturbance from oil-spill-cleanup activities; small changes in population and employment; and disruption of subsistence-harvest patterns from oil spills and oil-spill cleanup. Disturbance effects could periodically disrupt, but not displace, ongoing social systems, community activities, and traditional practices for harvesting, sharing, and processing subsistence resources. Community activities and traditional practices for harvesting, sharing, and processing subsistence resources could be seriously curtailed in the short term if there are concerns over the tainting of bowhead whales from an oil spill.

Environmental Justice: For a discussion of Environmental Justice cumulative effects, see Section V.C.16.

V.C.13. Archaeological Resources

V.C.13.a. Cumulative Effects on Archaeological Resources

The greatest cumulative effect on archaeological resources in the Beaufort Sea Sale 186, 195, and 202 area is from natural processes such as ice gouging, bottom scour, and thermokarst erosion. Because the destructive effects of natural processes are cumulative, they have affected and will continue to affect archaeological resources in this area.

Accidental oil spills would affect onshore archaeological sites the most, but past cleanups have shown us that spilled oil had little direct effect on archaeological resources (Bittner, 1993). Following the *Exxon Valdez* spill, the greatest effects came from vandalism, because more people knew about the locations of the resources and were present at the sites. Various mitigating measures used to protect archaeological sites while cleaning up oil spills are avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, scientific collection of artifacts, and programs to make people aware of cultural resources (Haggarty et al., 1991).

Although archaeological resources are not renewable, they are not affected directly or cumulatively by oil spills, the build up of toxic substances, noise, or air pollution. Effects are minimized due to modern technologies and practices that reduce the impact to the environment and therefore to archaeological resources (no thawing of permafrost, restricted personnel access, wintertime operations, small-footprint drilling and transportation technologies). Furthermore, mitigating measures, such as offshore high-resolution seismic surveys with archaeological analysis in zones of potential resources, and onshore archaeological surveys where offshore pipelines make landfall, will avoid damage or destruction of potential archaeological resources.

V.C.13.b. Transportation Effects on Archaeological Resources

The expected effect on onshore archaeological resources from potential future oil-spills from tanker or pipeline transportation of arctic oil is uncertain; however, data from the *Exxon Valdez* oil spill indicate that less than 3% of the resources within a spill area would be significantly affected (Dekin, 1993).

A potential tanker or pipeline spill would affect archaeological resources by creating surface-disturbing activities resulting from emergency shoreline and contaminated ground treatment. Following the *Exxon Valdez* oil spill, Exxon developed and funded a Cultural Resource Program to ensure that potential effects on archaeological sites were minimized during shoreline treatment (Betts et al., 1991). This program involved a team of archaeologists who performed reconnaissance surveys of the affected beach segments, reviewed proposed oil-spill treatment, and monitored treatment. As a result of the coastline surveys, hundreds of archaeological sites were discovered, recorded, and verified. This resulted in the most comprehensive archaeological record of Alaska coastline ever documented.

Although a number of sites in the *Exxon Valdez* spill area were vandalized during the 1989 cleanup season, the large number of Exxon and Government agency archaeologists visible in the field may have lessened the amount of site vandalism that may have occurred (Mobley et al., 1990).

The Dekin (1993) study found that small amounts of petroleum hydrocarbons may occur in most archaeological sites within the study area. This suggests a low-level petroleum contamination that previously had not been suspected. Because the researchers found no evidence of extensive soil contamination from a single definable source (the oil spilled from the *Exxon Valdez*), they “now add the continuing contamination of soils from small and large petroleum spills in areas where present and past land use coincide” (Dekin, 1993). Vandalism was found to have a significant effect on archaeological site integrity but could not be tied directly to the oil spill (Dekin, 1993).

Summary and Conclusions for Beaufort Sea, North Slope, and Transportation Activities on Archaeological Resources. In addition to Alternative I for Sale 186, other activities associated with this cumulative analysis that may affect archaeological resources in the Beaufort Sea include lease sales and activity in the National Petroleum Reserve-Alaska and State lands, State oil and gas fields, oil and gas transportation, noncrude carriers, and any Federal activities. Cumulatively, these proposed projects likely would disturb the seafloor more often, but remote-sensing surveys made before approval of any Federal or State lease actions should keep these effects low. Federal laws would preclude effects to most archaeological resources from these planned activities.

Contribution of Alternative I for Sale 186 to Cumulative Effects: The contribution of Alternative I for Sale 186 to the cumulative case is expected to be minimal for archaeological resources, because any surface-disturbing activities that could damage archaeological sites would be mitigated by current State and Federal procedures, which require identification and mitigation of archaeological resources in the proposed project areas.

Overall effects of the Alternative I for Sale 186 would be additive to effects anticipated for other future projects and, in the case of oil spills, is uncertain. However, data from the *Exxon Valdez* oil spill indicate that less than 3% of the resources within a spill area would be significantly affected.

V.C.14. Land Use Plans and Coastal Zone Management

V.C.14.a. Land Use Plans

The development projects that constitute the basis of the assessments in this section are described in Section IV. Many of the projects included in the cumulative case could occur on Federal lands, including the OCS, as well as lands covered by the North Slope Borough Land Management Regulations. Because the Land Management Regulations' areawide policies are the same as those developed by the North Slope Borough for the NSB CMP, the areawide policies of the Land Management Regulations are incorporated into the section on coastal management.

V.C.14.b. Coastal Zone Management

Cumulative effects may lead to changes in the level of effects. However, ACMP statewide standards and NSB CMP policies that are relevant to the analysis in Section IV Land Use Plans and Coastal Management Programs remain relevant for the cumulative. The following paragraphs focus only on the differences in the analysis in Section IV. Although the level of effects may increase for the cumulative, the hypothetical activities described in the scenarios are not expected to conflict with the statewide standards and NSB CMP policies. Activities that occur within the North Slope Borough boundary, including the offshore coastal zone area, will require permitting and approval from the North Slope Borough prior to those activities proceeding. Activities will not be approved by the Borough until it is certain they do not conflict with the CMP policies.

V.C.14.b(1) Energy Facilities (6 AAC 80.078), Transportation and Utilities (6 AAC 80.080), and Habitats (6 AAC 80.130)

The effects of pipelines, roads, and facilities installation and construction are magnified in the cumulative case. However, the analyses indicate that the potential additive effects will not significantly alter or interfere with the habitats, species, and activities that these standards address. Cumulative effects are not anticipated to increase the potential for conflict with these Statewide standards. Siting of energy facilities, transportation, and utilities within the boundaries of the North Slope Borough and the offshore coastal zone would require North Slope Borough permitting and approval. The NSB CMP policies would be addressed through this approval process and permitting would be dependent upon adherence to these policies.

V.C.14.b(2) Subsistence (6 AAC 80.120)

Access to subsistence-hunting areas and subsistence resources and the use of subsistence resources could change, if development reduces the availability of resources or alters their distribution patterns. Sources that could affect subsistence resources and access include noise and traffic disturbance, disturbance from construction activities associated with ice roads, production facilities, pipelines, gravel mining, supply efforts, and the unlikely event of a large oil spill and associated cleanup efforts. Of these, the unlikely event of a large spill is the only source that could significantly interfere with access to subsistence resources. If a large spill occurred and contaminated essential harvesting areas, effects could occur when impacts from contamination, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together.

The other affects agents are not expected to have any more than local, short-term effects or can be effectively addressed through mitigation such as the stipulations on Conflict Avoidance and Industry Site-Specific Whale-Monitoring Program. Noise effects from seismic activities can be eliminated or substantially reduced by the coordination and location of seismic activities. Offshore facility access and helicopter routes can be planned to minimize operations in the vicinity of migrating whales. Existing mitigation and eventual permit conditions for future projects would examine the timing and monitoring of potential noise sources to prevent conflicts with subsistence whalers. Therefore, activities addressed for cumulative effects are not likely to result in conflict with this Statewide standard or with the NSB CMP policies addressed in Section IV. Activities occurring within the boundaries of the North Slope Borough will require Borough permitting and approval.

Summary: Access to subsistence-hunting and subsistence resources offers the greatest opportunity for conflict with the Statewide standards and the NSB CMP policies related to these concerns. Increases in noise and disturbance from cumulative oil development could have localized short-term effects on some subsistence resources and access to those resources. The resource of most concern is bowhead whales. The concern relates to the potential for noise to disrupt the normal migration of bowhead whales, forcing subsistence whalers into longer hunts farther from shore. In the unlikely event of a large oil spill occurring in the migration route, the bowhead whale could be tainted and the harvest disrupted, although bowhead whales still would be available. However, tainting concerns would remain.

Noise and disruption can be effectively addressed through mitigation, coordination and through future permitting processes, including Federal, State, and local processes as applicable. A large oil spill is an accidental event. Federal regulations require and implement strict oil-spill prevention standards and a large oil spill is considered unlikely.

Conclusion: The potential for conflicts arising from the cumulative case is the same as those discussed in Section. IV.C - Effects Common to All Alternatives. Conflicts with Statewide standards of the ACMP and the policies of the NSB CMP are not inherent in the hypothetical scenarios presented in the cumulative case.

Contribution of Alternative I for Sale 186 to the Cumulative Potential for Conflict: Alternative I for Sale 186 represents a small proportion (7%) of the total past, present, and reasonably foreseeable oil and gas development in the Beaufort Sea area. No conflicts are anticipated for activities associated with Alternative I for Sale 186, and its contribution to the cumulative case does not alter the conclusion for the cumulative case. This conclusion is based partly on the small contribution of Alternative 1for Sale 186, but predominantly on the conclusion that exploration and development and production can proceed consistent with the enforceable policies of the ACMP and the NSB CMP. The MMS regulatory oversight and lease stipulations address many of the concerns applicable to the enforceable standards. In addition, the consistency review of these activities will address the applicable policies at the time that specific plans are submitted.

V.C.15. Air Quality

V.C.15.a. Details of Cumulative Effects on Air Quality

Despite considerable oil and gas related activity since 1969, the overall air quality on the North Slope of Alaska remains relatively pristine. See Section III.A.6 for a discussion of the existing environment.

Table V-2 shows that Prudhoe Bay and Kuparuk are the big oil producers. However, their production will continue to decline over the coming years. Air monitoring at a number of sites in the Kuparuk and Prudhoe Bay fields showed that concentrations of nitrogen dioxide, sulfur dioxide, and PM_{10} are well within the national ambient air-quality standards. BPXA's air quality modeling for the Liberty Project indicated that emissions from the Prudhoe Bay and Kuparuk fields have very little effect on ambient concentrations elsewhere. Their air quality modeling for their project also indicated that maximum concentrations would occur within about 100-200 meters from the facility boundary and would be considerably lower at 1 kilometer from the facility. We consider that their results are representative of what we could expect from any development resulting from Alternative I for Sale 186. Thus, there would be very little cumulative interaction between developments under this and other oil-producing facilities.

Potential impacts from future lease sales on the OCS and on land are difficult to evaluate. However, we can expect that any development would be scattered over a rather large area. Modeling performed for the Sale 144 final EIS (USDOI, MMS, 1996a) showed that impacts from widely scattered emissions sources on the OCS are small and well within regulatory standards. The Final 5-Year Program EIS for 2002-2007 (USDOI, MMS, 2002a) discusses the cumulative effects of the program in all areas. The relevant major finding was that no major degradation of onshore air quality is predicted. Emissions associated with routine program activities could cause small increases in onshore concentrations of some air pollutants. Emissions should not cause any exceedance of national or State air quality standards. In the unlikely event of a large oil spill, the accidental oil spill could cause rapid and perhaps dramatic increases in volatile organic carbon concentrations near the spill, but the duration of these should be too short (generally a few days) to cause major impacts.

A more comprehensive discussion occurs in the Impacts on Air Quality sections of that document (USDOI, MMS, 2002a:Sections 4.3.2.2 and 4.3.3.2); we incorporate that discussion here by reference. Section 4.3.2.2 (pertaining to the Gulf of Mexico) includes also a general discussion of ambient air quality standards, the effects of pollutants, and the type and relative amounts of pollutants generated by offshore operations. Section 4.3.3.2 (specific to Alaska) discusses the most commonly emitted air pollutants associated with Alaska OCS oil and gas activities, including operations affected by ice cover, the construction of ice islands and gravel islands, and the concentration of activities into short timeframes. The conclusions drawn there are that the impacts from the 5-year program on the pollutant levels, the ozone levels, and visibility all would be minor or negligible. Section V.C.13 of the Liberty final EIS (USDOI, MMS, Alaska OCS Region, 2002a) discusses the cumulative effects on air quality of all North Slope oil and gas activity since 1969. It concludes that the cumulative effects of all projects affecting that area in the past and occurring now have caused generally little deterioration in air quality, which remains better than required by national standards. The Northstar and Liberty projects and all other reasonably foreseeable North Slope projects would not change this situation. Also, Sections IV.C.15.b(2)(a) and IV.C.15.b(2)(b) of this EIS conclude that from small oil spills there would be a small, very localized increase in concentration of hydrocarbons. Concentrations of criteria pollutants would remain well within Federal air quality standards. The overall effects on air quality would be very low.

Total emissions from development for all three of the Beaufort Sea sales considered in this EIS (Sales 186, 195, and 202) would be from the installation of a maximum of 8 platforms and 115 miles of pipeline, and the drilling of a maximum of 206 production wells and 100 injection wells. In the peak years, a probable maximum of 28 wells per year would be drilled from four rigs. Peak-year production emissions would result from operations producing about 100 million barrels of oil and from transportation of that oil. The total production is estimated to be 1,380 million barrels over 39 years, which averages to about 35 million barrels per year, or 97,000 barrels per day. (See Appendix F - Exploration and Development Scenarios and Table F-2 for more details of the expected infrastructure.)

We could expect very little cumulative interaction between emissions from developments resulting from Alternative I for Sale 186 and any other existing, planned, or potential oil or gas development projects. For the area as a whole, we could expect the quality of the air to increase in those areas where oil production currently is the greatest and to decline in other areas where future development is expected to take place. It is possible that new development would be relatively scattered and, therefore, regional impacts would be small, except for higher, localized concentrations in the immediate vicinity of production facilities.

We also expect that no synergistic effects will affect air quality.

Arctic Haze: Arctic haze is a phenomenon resulting from elevated concentrations of fine particulate matter that are found over the Arctic, primarily in winter and spring. Scientists believe that most of these pollutants are attributed to combustion sources in Europe and Asia. It is not known to what extent local sources in Alaska contribute to arctic haze in the area of the Beaufort Sea. However, the arctic haze phenomenon was first observed in the 1950's, long before oil development started on the North Slope. Also, emissions in the general area are expected to decrease due to a downward trend in oil production and, thus, any possible contribution to arctic haze would be reduced. Projected emissions from development resulting from the proposed Beaufort Sea multiple-sale proposal are small compared to the emissions from the Prudhoe Bay and Kuparuk oil field production. For example, actual emissions reported for the Prudhoe Bay oil fields for the year 1994-1995 listed 56,000 tons of nitrogen oxide, 1,471 tons of sulfur dioxide, and 6,200 tons of PM_{10} (U.S. Army Corps of Engineers, 1999:Table 5.4-7). Projected emissions from Alternative I for Sale 186 would be only a small percentage of those figures. Therefore, any contribution from Alternative I for Sale 186 to arctic haze would be minor.

Global Climate Change: The global climate change analysis performed for the Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007 (USDOI, MMS, 2002a:Section 4.1.2 and Tables 4-7a and 4-7b) estimated that the emission rate of greenhouse gases (carbon dioxide, methane, and nitrous oxide) from cumulative OCS activities for Alaska would be from 381,000-723,000 metric tons of carbon equivalent per year for carbon dioxide and from 1,100-2,100 metric tons of carbon equivalent per year for methane. Emissions of nitrous oxide were not calculated due to a lack of information about emission factors. However, these emissions are expected to be much smaller than for the other greenhouse gases. The total estimated greenhouse gas emissions from Beaufort Sea Sales 186, 195, and 202, including emissions from tanker transport to U.S. West Coast ports, were from 177-311 million metric tons of carbon equivalent. This is about 0.01-0.02% of current nationwide greenhouse gas emissions. The Northstar EIS estimated that the greenhouse gas emissions from current North Slope oil production (including shipping, refining, end-product transportation, and consumption) is about 1% of the global fossil-fuel greenhouse gas emissions (U.S. Army Corps of Engineers, 1999). (Emissions from the actual combustion of oil produced are much greater than that from just the production activities.) For Alternative I for Sale 186, the peak oil production rate is 43.6 million barrels per year, or about 120,000 barrels per day. This is about 8% of current North Slope oil production, or 0.08% of global fossil fuel greenhouse gas emissions.

The cumulative analysis for Alternative I for Sale 186 considers three ranges of onshore and offshore future production activity. The low range includes reserves in currently producing fields and resources and discoveries in the planning or development stage. The midrange consists of the low-range figure plus any reasonably foreseeable future production. The high range adds in potential speculative future production. If we use the midrange estimate, which is 11 billion barrels of oil, and assume that this entire amount is produced over a 20-year period, we get an average production rate of about 1.4 million barrels of oil per day. This is very close to the 1996 North Slope oil-production rate. While it is difficult to precisely estimate greenhouse gas emissions from future oil and gas production activities in Northern Alaska, one may assume that the greenhouse gas emissions would be proportional to the oil-production rate at the same ratio as presently exists. Based on that assumption, the regional greenhouse gas emissions associated with future cumulative production would be about the same as the 1996 North Slope emission levels. This is about 30% higher than current levels (since the 1999 North Slope production rate was about 1.1 million barrels of oil per day). Greenhouse gas emissions associated with production activities can be reduced by using more fuel-efficient power generators and minimizing flaring. Based on the Northstar analysis cited above, the cumulative future oil production in northern Alaska would produce a relatively small (about 1%) contribution to global greenhouse gas emissions. The Alternative I (Sale 186) production of 460 million barrels over 24 years averages to about 19 million barrels per year, or 52,000 barrels per day. This is about 3.5% of current North Slope production and greenhouse gas emissions. The contributions of Beaufort Sea Sales 186, 195, and 202 would represent about 6.7% of current North Slope production and greenhouse gas emissions. Nationwide and global greenhouse gas emissions can be reduced by energy conservation, improving energy efficiency, and developing alternative energy sources. Regardless of any downward pressure on the growth of oil consumption in the future as a result of measures to reduce greenhouse gas emissions, the need for continued development of domestic new oil and gas resources still will exist. If Alaska energy sources were not to be developed in the future, resources would have to be produced in other areas of the globe. The impacts on greenhouse gas emissions would be very similar, regardless of the location of the energy source.

V.C.15.b. Transportation Effects on Air Quality

The transportation of crude oil to market by tankers would result in air emissions from the tankers' engines during loading operations, transit, and unloading. These emissions would consist primarily of nitrogen oxides, sulfur dioxide, and particulate matter. Emissions of volatile organic compounds also would occur during tanker loading and unloading operations. Emissions of nitrogen oxides and volatile organic compounds would be of concern in ports located within ozone nonattainment areas because of their potential to contribute to tropospheric ozone levels. In these areas, local regulations commonly require the use of vapor-balance systems to substantially reduce volatile organic compound emissions. For any particular port, the emissions would be intermittent, and nitrogen dioxide, sulfur dioxide, and particulate matter concentrations would be within ambient air quality standards. Impacts from emissions during transit would be very small, because emissions would be dispersed over a large area.

A major oil spill would result in a localized increase in ambient volatile organic compounds concentrations due to evaporation from the spill. Details on the effects of an oil spill and impacts associated with in situ burning are provided in Section IX.B.3.m of the Liberty final EIS (USDOI, MMS, Alaska OCS Region, 2002a) and in Section IV.A.6(b) of this EIS. Overall air quality impacts from transportation would be low.

Summary and Conclusions for Beaufort Sea, North Slope, and Transportation Activities on Air Quality. The cumulative effects of all projects affecting the North Slope of Alaska in the past and occurring now have caused generally little deterioration in air quality, which remains better than required by national standards. All reasonably foreseeable North Slope projects (see Table V-1a) would not change this situation. We also expect that no synergistic effects will affect air quality.

Contribution of Alternative I for Sale 186 to Cumulative Effects: Considering that predicted discoveries and development from Alternative I for Sale 186 would represent only a few percent of the existing North Slope activity, air emissions from Alternative I, Sale 186 would have no significant cumulative effects on air quality. See Section IV.C.15 for a discussion of these emissions.

V.C.16. Environmental Justice

Alaska Inupiat Natives, a recognized minority, are the predominant residents of the North Slope Borough, the area potentially most affected by Alternative I for Sale 186 exploration and development. Effects on Inupiat Natives could occur because of their reliance on subsistence foods, and cumulative effects may affect subsistence resources and harvest practices. Potential effects from noise, disturbance, and oil spills on subsistence resources and practices and sociocultural patterns would focus on the Inupiat communities of Barrow, Nuiqsut, and Kaktovik, within the North Slope Borough. For a detailed discussion of Environmental Justice effects, see Section IV.C.16 and the cumulative-effects analyses for subsistence-harvest patterns and sociocultural systems in Sections V.C.11 and V.C.12.

Additional Aspects of Environmental Justice Cumulative Impacts. The MMS acknowledges sociocultural cumulative impacts on the North Slope and that Inupiat culture has undergone significant change (see Sec. IV.C.12, Effects on Sociocultural Systems). The influx of money and a changing landscape due to wage employment has added many benefits and raised the standard of living, but these influences also have given rise to an array of social pathologies that include increased alcoholism. However, cumulative effects are difficult to separate and, by far, most cumulative effects result from onshore development, as the oil patch spreads outward from Prudhoe Bay/Deadhorse.

One point that was made numerous times at a Research Design Workshop for the Bowhead Whale Subsistence Hunt and OCS Oil and Gas Activities convened by MMS in April 2001 in Anchorage, was that any realistic analysis of cumulative effects on the North Slope needs to consider both onshore and offshore effects. To date, the most obvious cumulative effects have occurred and continue to occur onshore, although no adequate monitoring or comprehensive baseline data gathering has ever been undertaken onshore by responsible Federal and State agencies and industry. Most of the stress factors mentioned by local stakeholders normally can be associated with onshore impacts. Until a serious onshore-monitoring program is developed, causal linkages to impacts from onshore or offshore sources will be problematic.

Mitigating Initiatives Related to Environmental Justice Cumulative Impacts. For a discussion of standard and proposed mitigation measures and other ongoing mitigating initiatives that relate to environmental justice concerns, see Section IV.C.16.

Additionally, if development occurred, MMS would encourage development of a standing interagency-intergovernmental working group that would include local and regional North Slope governments, State and Federal land management agencies, and industry to consult, coordinate, design, and monitor solutions to subsistence and sociocultural cumulative impacts on- and offshore. Such a body would better serve the concerns of subsistence hunters and lead to more balanced decisions on approaches to long-term monitoring and the proper assessment of oil-activity cumulative impacts on subsistence resources and harvests and Inupiat culture. After its 1998 lease sale in the Petroleum Reserve, the Bureau of Land Management established a National Petroleum Reserve-Alaska Subsistence Advisory Panel and an

Interagency Research and Monitoring Team that includes the Bureau of Land Management, the Fish and Wildlife Service, other Federal agencies, the State of Alaska, the North Slope Borough, and local North Slope groups who meet to address local subsistence concerns. A similar offshore panel could be established if development occurs.

In its November 2001 meeting, the OCS Policy Committee discussed the possibility of the Department of the Interior determining a way to provide funds to tribal and local governments for training and travel needs to facilitate their participation in Department of the Interior planning and decisionmaking processes. Without funding, these executive orders are perceived by the Native community simply as new "unfunded mandates." Funding of this nature would ameliorate some of the stress caused in small Native villages from the burden of participation in the agency public process.

More specifically, and based on Native stakeholder concern, the MMS has addressed cumulative impacts by redesigning its approach to oil-spill risk to make its methodology better suited to the Arctic region. Also, based on stakeholder concern, the MMS has redesigned its EIS analysis of cumulative effects. These changes are reflected in the Liberty EIS and in this EIS. Another initiative pursued by the MMS to improve its analysis of cumulative impacts has been through a cooperative agreement with the Alaska Department of Fish and Game, Subsistence Division, whereby MMS provides funding for the collection and maintenance of the State-maintained Community Profile Database, which is the only long-term archive of subsistence data in the State.

Ongoing and proposed MMS studies that address environmental justice concerns will provide valuable data for the assessment of cumulative impacts of oil and gas activities. Monitoring efforts for the Northstar and Liberty projects, such as the 14-year aerial Monitoring of the Distribution of Arctic Whales Project, will provide long-term information on areawide and cumulative effects of oil and gas activities on the fall migration of the bowhead whale and help in the development of mitigation measures to protect this pivotal Inupiat subsistence resource. A top-priority 5-year, $3.7 million ANIMIDA study was established in response to Inupiat requests to gather long-term monitoring data that will provide a basis for evaluating potential effects from upcoming development and production activities in the Beaufort Sea. A portion of this study will assess the historic and ongoing subsistence use of the area surrounding Cross Island by working with local whale hunters. The intent of the *Exxon Valdez Oil Spill, Cleanup, and Litigation: A Community-Based Collection of Social-Impacts Information and Analysis, 1989-2001* study is to produce an analytical tool from the synthesis of the *Exxon Valdez* literature that would assist MMS analysts in preparing National Environmental Policy Act documents, the design of mitigating measures, facilitate the review of oil-spill-contingency plans, and pave the way for a dialogue with coastal communities regarding the MMS offshore program. The *Quantitative Description of Potential Effects of OCS Activities on Bowhead Whale Hunting Subsistence Activities in the Beaufort Sea* study was developed in response to concerns raised by the Alaska Eskimo Whaling Commission and the North Slope Borough. This study will involve a systematic analysis of residents' observations and perceptions about how their lives, and especially subsistence whale hunting activities, have been and might in the future be affected by oil-industry activities and other forces of modernity. A study titled *Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow: Past and Present Comparison* is ongoing and will map geographic patterns of subsistence use near important North Slope communities. The MMS will use this comparative time-series information to assess cumulative sociocultural effects in the Beaufort Sea region. The ongoing Alaska Marine Mammal Tissue Archival Project field sampling and long-term storage of frozen tissues archive has provided a wealth of information on contaminants. A proposed study called "the Alaska Marine Mammal Health and Contaminants Database" will make this tissue-archival information available to management agencies and subsistence villages that, by necessity, need to make timely decisions about the safety of the environment and subsistence foods. Finally, an ongoing study titled *North Slope Borough Economy, 1965 to Present* will provide a comparative basis for assessing potential economic effects of upcoming offshore oil and gas activity to better assess potential cumulative effects of offshore oil and gas development. Another aspect of this study will be to consider and estimate economic effects from decreasing oil- and gas-development revenues at Prudhoe Bay and assess community impacts.

In April 2001, the MMS held The Bowhead Whale Subsistence Hunt and Outer Continental Shelf Oil and Gas Activities Research Design Workshop in Anchorage. This workshop was requested by the National Marine Fisheries Service and the Alaska Eskimo Whaling Commission to better focus scientific research on the cumulative effects of OCS activity on bowhead whales and their migration, in addition to the sociocultural dimensions of the subsistence whale hunt. Recommendations from the workshop identified: (1) the need for extensive funding to effectively study the complex relationship between OCS and onshore socioeconomic effects; (2) the need for effective monitoring to document and analyze industry and whaling activities and the many factors of change in local communities; (3) that defining and disaggregating (on- and offshore) cumulative social effects will be a difficult process; and (4) that defining the relative causal effect of any given factor, such as OCS oil and gas activity, on social problems is problematic. Participants agreed that available resources would better be applied to researching means of prevention, intervention, and treatment of social problems in North Slope Native communities.

The MMS, in conjunction with the North Slope Borough Wildlife Management Department, helped sponsor an Information Transfer Meeting in Anchorage in January 1999 and the Beaufort Sea Information Update Meeting in Barrow in March 2000 to present updates on research and studies being conducted in the Beaufort Sea. The March 1999 meeting included presentations by Barrow, Nuiqsut, and Kaktovik whaling captains. Future meetings on the North Slope are expected.

While these efforts in themselves would not resolve the larger problems of ongoing cultural challenge to Inupiat traditions from increasing development in the region and from the powerful influences of modernity, such as cable television, the Internet, and an increasing dependence on a wage-based economy, they provide processes for information sharing and opportunities for mutual decisionmaking and remediation of cumulative social and subsistence impacts.

Conclusion: Potential effects would focus on the Inupiat communities of Barrow, Nuiqsut, and Kaktovik, within the North Slope Borough; however, effects are not expected from routine activities and operations. If a large spill assumed in the cumulative case occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Such impacts would be considered disproportionately high adverse effects on Alaskan Natives, because oil-spill contamination of subsistence foods is the main concern regarding potential effects on Native health. Any potential effects to subsistence resources and subsistence harvests are expected to be mitigated substantially, though not eliminated.

Contribution of Alternative I for Sale 186 to Cumulative Effects: Only in the event of a large spill, which is a low likelihood event, would disproportionate high adverse effects be expected on Alaska Natives from Alternative I for Sale 186.

SECTION VI

CONSULTATION

AND

COORDINATION

CONTENTS OF SECTION VI

VI. CONSULTATION AND COORDINATION

VI.A. Development of the Proposals

As scheduled in the current OCS 5-Year Oil and Gas Leasing Program (2002–2007), the Secretary has decided to have three sales in the Alaska Region's Beaufort Sea Planning Area. Sale 186 is scheduled in 2003, Sale 195 in 2005, and Sale 202 in 2007. In keeping with the Secretary's decision, the MMS has modified its prelease planning and decision process and has prepared a single EIS for all three Beaufort Sea sales (proposed actions). Official coordination with other government agencies, industry, and the public regarding these proposed actions began on September 19, 2001, with a Call for Information and Nominations (Call) and Notice of Intent (NOI) to Prepare an Environmental Impact Statement. This Call/NOI requested expressions of industry interest in blocks within the Call area and requested comments on environmental issues related to possible oil and gas leasing in the area. As a result of the Call/NOI, nine written comments and/or nominations were received. Three companies commented and nominated blocks, and six written responses were received from the following: the State of Alaska, Office of the Governor, Division of Governmental Coordination; the North Slope Borough, Office of the Mayor; North Slope Borough Planning Department Director; the Alaska Eskimo Whaling Commission, Director; City of Wainwright, Mayor; combined letter from the Sierra Club, Arctic Connections, The Wilderness Society, and Greenpeace; Phillips Alaska Exploration; Shell Oil; and British Petroleum (Alaska) Inc.

Following evaluation of the area nominations and environmental information received in the EIS process described, together with other relevant information, the MMS submitted a recommendation for area selection to the Secretary of the Interior. On January 10, 2002, the Department of the Interior announced the area selected for further environmental study (see Section I.A for more details).

VI.B Development of the EIS

During preparation of this Beaufort Sea Planning Area multiple-sale EIS, Federal, State, and local agencies; industry; and the public were consulted to obtain descriptive information, identify significant effects and issues, and identify effective mitigating measures and reasonable alternatives to the proposed action. The comments received during the scoping process for this EIS also noted that issues raised and mitigating measures and alternatives suggested for past Beaufort Sea Planning Area lease sales were relevant to the multiple sales. All of the information received has been considered in preparing the draft EIS. In addition, scoping meetings on the draft EIS, were held in Barrow, Nuiqsut, Kaktovik, and Anchorage, Alaska, with local agencies and the public to more clearly and specifically identify issues and alternatives to be studied in the draft EIS. Scoping information can be found in Section I.C and the Scoping Report in Appendix E. The North Slope Borough local communities, in addition to departmental agencies with interest and expertise in the OCS, were consulted during the development of the potential mitigating measures for these proposed actions.

In addition, Executive Order 13175 (Consultation and Coordination with Indian Tribal Governments), states that the U.S. Government will continue "to work with Indian tribes on a government-to-government basis to address issues concerning Indian tribal self-government, trust resources, and Indian tribal treaty and other rights." To meet that direction, MMS has met with the local tribal governments of Barrow, Nuiqsut, and Kaktovik; in addition to the Inupiat Community of the Arctic Slope (the recognized regional tribal government), and an important nongovernmental Native organization, the Alaska Eskimo Whaling Commission. These tribal governments and the Alaska Eskimo Whaling Commission were contacted by letter and given the opportunity to participate in scoping meetings and the development of this EIS.

VI.C Contacts for Review of the EIS

The following are the major Federal, State, and local government agencies; academic institutions; members of the oil and gas industry; special interest groups; other organizations; and private citizens who were contacted during the preparation of this EIS, or past Beaufort Sea EIS's, and were sent copies of the draft EIS for review.

Federal – Executive Branch – Departments

Department of Commerce

National Marine Fisheries Service
- Bowhead Whale Project
- Regional Administrator, Juneau
- Alaska Regional Office, Anchorage

National Oceanic and Atmospheric Administration
- Policy and Strategic Planning

Department of Defense

U.S. Army Corps of Engineers
- Regulatory Branch, Alaska District

Deputy Under Secretary of Defense for Installations and Environment

Department of Energy

Technical Information Center

Department of Transportation

Office of Pipeline Safety

U.S. Coast Guard

Department of the Interior

Bureau of Indian Affairs
- Environmental Services
- West Central Alaska Field Office

Bureau of Land Management
- State Director
- Northern Field Office, Fairbanks

U.S. Fish and Wildlife Service
- Federal Activities Branch
- Regional Office
- Anchorage Ecological Services
- Fairbanks Ecological Services
- Migratory Bird Management
- Subsistence and Fisheries

U.S. Geological Survey
- Alaska Science Center
- Environmental Affairs Program

National Park Service
- Regional Director
- Division of Environmental Quality
- Subsistence Division

Office of Environmental Policy and Compliance

Special Assistant to the Secretary for Alaska

Federal – Legislative Branch

U.S. Senate

Alaska delegates

U.S. House of Representatives

Alaska delegates

Federal – Administrative Agencies and Other Agencies

Arctic Research Commission

Marine Mammal Commission

Environmental Protection Agency

Office of Federal Activities

Region 10, NPDES Permit Unit

Alaska Operations Office, Anchorage

State of Alaska

Alaska Oil and Gas Conservation Commission

Department of Community and Regional Affairs

Department of Environmental Conservation
- Anchorage District Office
- Northern Alaska District Office

Department of Fish and Game
- Region II, H&R
- Subsistence Division
- Habitat Division

Department of Natural Resources
- Citizen's Advisory Commission on Federal Areas
- Division of Geological and Geophysical Surveys
- Division of Oil and Gas
- Division of Water, Fairbanks

Dept. of Transportation and Public Facilities
- State Pipeline Coordinator, Joint Pipeline Office

Office of the Governor
- Governor
- Division of Governmental Coordination
- Office of Budget and Management

Local Governments - Native Organizations

Alaska Eskimo Walrus Commission, Barrow
Alaska Eskimo Walrus Commission, Nome
Alaska Eskimo Whaling Commission
Alaska Federation of Natives
Alaska Inter-Tribal Council
Alaska Native Science Commission
Arctic Development Council, Barrow
Arctic Slope Native Association
Arctic Slope Regional Corporation
Atqasuk Inupiat Corporation, Atqasuk
Barrow Whaling Captains Association
Bering Straits CRSA, Unalakleet
City of Anaktuvuk Pass, Mayor
City of Barrow, Mayor
City of Kaktovik, Mayor
City of Kotzebue, Planning Dept.
City of Nome, City Manager
City of Nuiqsut, Mayor
City of Point Hope, Mayor
City of Wainwright, Mayor
Cully Corporation, Point Lay
Inupiat Community of the Arctic Slope (ICAS)
Kaktovik Inupiat Corporation
Kaktovik Whaling Captains Association
Nagsragmuit Tribal Council, Anaktuvuk Pass
Kuukpik Village Corporation, Nuiqsut
NANA Regional Corporation Inc., Kotzebue
Native Village of Barrow
- Wildlife Director
- Tribal Council President

Native Village of Kaktovik
Native Village of Nuiqsut
Native Village of Point Hope
Native Village of Point Lay
Native Village of Wainwright
North Slope Borough
- Department of Wildlife Management
- Mayor's Office
- Planning Department
- Public Information Office
- Village Coordinator, Anaktuvuk Pass
- Village Coordinator, Atqasuk
- Village Coordinator, Kaktovik
- Village Coordinator, Nuiqsut
- Village Coordinator, Point Hope
- Village Coordinator, Wainwright

Nunamiut Corporation, Anaktuvuk Pass
Olgoonik Corporation, Wainwright
Tigara Corporation, Point Hope
Ukpeagvik Inupiat Corporation

Libraries

Alaska Pacific University
  Academic Support Center Library
Alaska Resources Library and Information Service (ARLIS)
Alaska State Library
  Government Publications, Juneau
American Petroleum Institute Library, D.C.
Canadian Circumpolar Library, Edmonton AB
Canadian Joint Secretariat Librarian, Inuvikon NT
Department of Indian and Northern Affairs, Canada Yellowknife, NT
Environmental Protection Agency, Region 10
  Librarian, Seattle
Fairbanks North Star Borough
  Noel Wien Library
George Francis Memorial Library
Ilisaavik Library, Shishmaref
Juneau Public Library
Kaveolook School Library, Kaktovik
Kegoyah Kozpa Public Library, Nome
National Oceanic and Atmospheric Administration
Information Services Division, Seattle, WA
North Slope Borough School District
  Library/Media Center, Barrow
Northern Alaska Environmental Center Library
Tikigaq Library, Point Hope
Trapper School Community Library, Nuiqsut
Tuzzy Consortium Library, Barrow
University of Alaska, Anchorage
  Elmer E. Rasmuson Library
  Government Documents
University of Alaska, Fairbanks
  Geophysical Institute
  Government Documents
  Institute of Arctic Biology
University of Alaska, Southeast (Juneau)
U.S. Army Corps of Engineers Library, Anchorage
U.S. Fish and Wildlife Service Library, Anchorage
Valdez Consortium Library
Z.J. Loussac Library, Anchorage

Canada

Department of Fisheries and Oceans
  Institute of Ocean Sciences, Sidney, BC
Canadian Wildlife Service
  National Wildlife Research Division, Hull, PQ
Department of Indian and Northern Affairs
  Natural Resources and Economic Development, Ottawa

Special Interest Groups

Alaska Conservation Foundation
Alaska Native Knowledge Network, Fairbanks
Alaska Natural Heritage Program
Alaska Public Interest Research Group
Arctic Connections
Arctic Marine Resource Commission
Arctic Sounder, Kotzebue
Barrow Cable TV
Bering Air, Inc., Nome
Center for Biological Diversity
Defenders of Wildlife
EarthJustice, Juneau
Exxon Valdez Oil Spill Trustee Council
Greenpeace
Ilisagvik College, Barrow
Indigenous Peoples Council for Marine Mammals
KBRW News, Barrow
Living Resources, Inc. Fairbanks
Marine Advisory Program
National Audubon Society
National Parks and Conservation Association
National Resources Defense Council
National Wildlife Federation
Northwest and Alaska Fisheries Center
Ocean Conservancy
Rural CAP
Subsistence/Natural Resources Dept.
Sierra Club
Trustees for Alaska
University of Alaska, AEIDC, ENRI
Wilderness Society
Wildlife Federation of Alaska

Petroleum Industry

AEC Oil and Gas (USA) Inc.
Alaska Clean Seas
Alaska Support Industry Alliance
Amerada Hess Corporation
American Petroleum Institute
Amoco Production Co.
Anadarko Petroleum Corporation
Armstrong Oil and Gas Inc.
Atofina Petrochemicals, Inc.
BP Exploration (Alaska) Inc.
  Records Mgmt.
  Lands Mgr.
Chevron U.S.A. Inc.
Conoco, Inc.
Encana Oil and Gas, Inc.
Exxon Mobil Oil Corporation
Exxon Mobile Production Company
Forest Oil Corporation
Marathon Oil Company
Murphy Exploration (Alaska), Inc.
Pennzoil
Petro-Canada (Alaska) Inc.
Phillips Alaska, Inc.
  Environmental Protection Dept.
Phillips Petroleum Company
Shell Frontier Oil & Gas, Inc.
Texaco Inc.
Union Oil Company of California
Western Geophysical Company

Associations, Companies, and Other Groups

Alaska Journal of Commerce
Alaska Marine Conservation Council
Alaska Newspapers, Inc.
Alaska Oil and Gas Association
Alaska Public Radio Network, Anchorage
Anchorage Daily News
Continental Shelf Associates
Fairbanks Daily News-Miner
Guess and Rudd P.C.
I.H.S. Energy
LGL, Environmental Research
Lynx, Inc.
Oil and Gas Journal
Prince William Sound RCAC
Regional Director, MMS, GOM OCS Region
Regional Director, MMS, Pacific OCS Region
Steven R. Braund and Associates
URS Corporation
Waddell Marine Biotech

Individuals

Patsy Aamodt, Barrow
Fred Ahmaogak, Wainwright
George N. Ahmaogak, Barrow
Maggie Ahmaogak, Barrow
Morjorie Ahnupkana, Nuiqsut
Rosemary Ahtuangaruak, Nuiqsut
Freddie Aishanna, Kaktovik
Bendell Akootchook, Kaktovik
Isaac Akootchook, Kaktovik
Joseph K. Akpik, Barrow
Jim T. Allen, Nuiqsut
Lou I. Angisan, Kaktovik
Walt Audi, Kaktovik
Earl H. Beistline, Fairbanks
Barry Bodfish, Wainwright
Arnold Brower, Jr., Barrow
Charlotte Brower, Barrow
Eugene Brower, Barrow
Maggie Hopson, Nuiqsut
Harry Hugo, Anaktuvuk Pass
Herbert Ipalook, Nuiqsut
Edward Itta, Barrow
Kathy Itta, Barrow
Shirley Kagak, Atqasuk
Fred Kanayurak, Barrow
Lydin Kisoadik, Nuiqsut
Jake Koonuk, Point Hope
Maggie Koraldy, Nuiqsut
Sarah Kunaknony, Nuiqsut
Bernie Kyld, Nuiqsut
Doreen Lampe, Barrow
Leonard Lampe, Nuiqsut
Martha Larepe, Nuiqsut
William Leavitt, Barrow
Jessica S. Levre, Alexandria, VA
Marie Lisborne, Point Lay
Enoch Oktollik, Wainwright
James Paktotak, Barrow
Emily Paniger, Nuiqsut
Peter Panik, Wainwright
Delbert Rexford, Barrow
Fenton Rexford, Kaktovik
Ladorne Rexford, Nuiqsut
Rosabelle Rexford, Barrow
Jack Schaefer, Point Hope
Willie Sielak, Jr., Nuiqsut
Aunuptana Simiktug, Nuiqsut
Abe Simmonds, Nuiqsut
Nolan Soloman, Kaktovik
Lon Sonsalla, Kaktovik
Jim Stimpfle, Nome
Debbie Suvlu, Barrow
Edward Syrjala, Centerville, MA
George Tagarook, Kaktovik

Individuals

Gordon Brower, Barrow
Ronald Brower, Sr., Barrow
Albert Driggs, Wainwright
Della Driggs, Barrow
Robert Edwardson, Barrow
Flores Elfoeelouk, Nuiqsut
Emma Eudiliak, Nuiqsut
John C. George, Barrow
Paul Gronholdt, Sand Point
Walter R. Grove, Nashville, TN
Jana Harcharek, Barrow
Edward Hopson, Barrow
John Hopson, Jr., Wainwright
Martha Hopson, Barrow
Tom Lohman, Anchorage
Dr. Don Ljungblad, Elk Mountain, WY
Frank Long, Nuiqsut
Gordan Matumack, Nuiqsut
Warren Matumeak, Barrow
Thomas Napageak, Nuiqsut
Billy Nashoalook, Sr., Wainwright
Polly Neejeranner, Nuiqsut
Silas Negovanna, Barrow
Ruth Nukapigak, Nuiqsut
Isaac Nukapigak, Nuiqsut
Eli Nukapigak, Nuiqsut
Joe Nulupih, Nuiqsut
Don Nulusee, Nuiqsut
Harry Tazruk, Wainwright
Kenneth Togarook, Wainwright
Alice Tpalook, Nuiqsut
Merylin Traynor, Kaktovik
Patsy Tukle, Nuiqsut
Frederick S. Tuklesik, Barrow
Rex Tuzroyluke, Point Hope
Joseph Upickson, Barrow
David Whitney, Washington, D.C.
Vera Williams, Barrow
Wasku Williams, Barrow
Emilly Wilson, Nuiqsut
Joeb Woodson, Nuiqsut
Sheri Yatlin, Fairbanks

VI.D Contributing Authors and Supporting Staff Members

Elinore M. Anker, Technical Publications Writer-Editor
Christy Bohl, Oil Spill Contingency Plan Coordinator
Michael Burwell, Socioeconomic Specialist
Doug Choromanski, Geologist
Jim Craig, Geologist
Raymond R. Emerson, Environmental Special Assistant
Donald J. Hansen, Wildlife Biologist
Matt Heller, GIS Programmer/Analyst
Ken Holland, Fisheries Biologist
Tim Holder, Socioeconomic Specialist
Joel Hubbard, Wildlife Biologist
Fred King, Chief Environmental Assessment Section, Project Manager
Steven Levi, Publication Specialist
Paul L. Lowry, Physical Scientist and Multiple-Sale Project Coordinator
Ida Menge, Cartographer
Tom Murrell, Petroleum Engineer
Thomas Newbury, Biological Oceanographer
Richard Newman, Physical Oceanographer
Kristopher Nuttall, EAS Secretary
Mazelle O. Parker, EIS Specialist
Beverly Sires, Minerals Leasing Specialist
Caryn Smith, Oceanographer
Janet Stan, Minerals Leasing Specialist
Paul Stang, Regional Supervisor, Leasing and Environment
Dennis Thurston, Geophysicist
John Tremont, Geographer
George Valiulis, Headquarters EIS Project Officer
Kate Wedemeyer, Fisheries Biologist
Frank Wendling, Wildlife Biologist