



Chukchi Sea Planning Area

Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea

Final Environmental
Impact Statement

Volume I
Executive Summary, Sections I Through VI



Alaska Outer Continental Shelf

OCS EIS/EA
MMS 2007-026

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Impact Statement**

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(Executive Summary and Sections I through VI)

Author
**Minerals Management Service
Alaska OCS Region**

Cooperating Agency
**U.S. Department of Commerce,
National Oceanographic and Atmospheric Administration,
National Marine Fisheries Service**

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

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**Chukchi Sea
Lease Sale 193
Environmental Impact Statement**

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

Lead Agency:

U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region
3801 Centerpoint Drive Suite 500
Anchorage, AK 99503-5823

Cooperating Agency:

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

Abstract: This environmental impact statement (EIS) examines a proposal for oil and gas leasing in the Chukchi Sea and three alternatives to this Proposed Action. This EIS also examines two alternatives for exploration seismic-survey permitting in 2007 in the proposed sale area. Sale 193 is currently scheduled to be held in 2008. The proposed sale includes consideration of 6,156 whole or partial blocks in the Chukchi Sea Planning Area, covering about 34 million acres.

The proposed sale area and two deferral alternatives (Alternatives III and IV) exclude a 15- to 50-mile-wide corridor along the coast, the polynya or Spring Lead System. 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. Alternative II is the No Lease Sale Alternative, which means cancellation of the sale. 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.

Seven standard lease stipulations and 24 Information to Lessees clauses are evaluated as part of the lease sale Proposed Action.

For further information regarding this EIS, contact:

Michael R. Salyer
Minerals Management Service
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503-5242
(907) 334-5261

James Bennett
Minerals Management Service
381 Elden Street (MS 4042)
Herndon, VA 20170-4817
(703) 787-1660

**ACRONYMS
ABBREVIATIONS
AND
SYMBOLS**

AAC	Alaska Administrative Code
ABWC	Alaska Beluga Whale Committee
ACC	Alaska Coastal Current
ACIA	Arctic Climate Impact Assessment
ACMP	Alaska Coastal Management Program
ACS	Alaska Clean Seas
ACW	Alaska Coastal Water
ACZMP	Alaska Coastal Zone Management Program
ADCED	Alaska Department of Community and Economic Development
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
AEWC	Alaska Eskimo Whaling Commission
AGL	above ground level (altitude)
AI/AN	American Indian and Alaskan Native populations
AIS	aquatic invasive species
AMAP	Arctic Monitoring and Assessment Program
AMG	autometallography
ANCSA	Alaska Native Claims Settlement Act
ANGTS	Alaska Natural Gas Transportation System
ANILCA	Alaska National Interest Land Conservation Act
ANIMIDA	Arctic Nearshore Impact Monitoring In Development Areas
ANS	aquatic nuisance species
ANTHC	Alaska Native Tribal Health Consortium
ANWR	Arctic National Wildlife Refuge
AO	Arctic Oscillation
API	American Petroleum Institute
APD	Application for Permit to Drill
AQCR	Air Quality Control Regions
ARBO	Arctic Region Biological Opinion
ARCUS	Arctic Research Consortium of the United States
ASL	above sea level (altitude)
ASRC	Arctic Slope Regional Corporation
ASWG	Alaska Shorebird Working Group
bbl	barrel(s)
Bbbl	billion barrels
BCB	Bering-Chukchi-Beaufort Seas stock of bowhead whales
Bcf	billion cubic feet
Bcf/yr	billion cubic feet per year
BE	Biological Evaluation
BLM	Bureau of Land Management
BO	Biological Opinion
BOP	blowout preventer (system)
B.P.	Before Present
BP	British Petroleum
bpd	barrels per day
BPXA	British Petroleum Exploration (Alaska)
bsl	below modern sea level
BSW	Bering Shelf Water
BWASP	Bowhead Whale Aerial Survey Project
CAA	Clean Air Act or Conflict Avoidance Agreement
CAH	Central Arctic (caribou) Herd
Call	Call for Interest/Call for Nominations
CANIMIDA	Continuation of Arctic Nearshore Impact Monitoring In Development Areas
CBD	Center for Biological Diversity
CBS	Chukchi/Bering Seas stock of polar bears
CDFO	Canadian Department of Fisheries and Oceans
CEQ	Council on Environmental Quality

CER	Categorical Exclusion Review
CFC's	chlorofluorocarbons
CFR	Code of Federal Regulations
CH ₃ Hg	methyl mercury
CI	confidence interval
CIAP	Coastal Impact Assistance Program
CIP	Capital Improvement Program
cm	centimeter(s)
CO	carbon monoxide
COY	cubs of the year (polar bears)
CWA	Clean Water Act
CZARA	Coastal Zone Act Reauthorization Amendments of 1990
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Program
CYP1A	cytochrome P4501A
dB	decibel(s)
dB re 1 μPa	decibels re 1 microPascal
DEW	Distant Early Warning (system)
DHHS	Department of Health and Human Services (Federal)
DMT	Delong Mountain Terminal
DO	dissolved oxygen
DPP	Development and Production Plan
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EJ	Environmental Justice
EO	Executive Order
EP	Exploration Plan
ERA	Environmental Resource Area
ESA	Endangered Species Act
EVOS	<i>Exxon Valdez</i> oil spill
EWC	Eskimo Walrus Commission
FMC	Fishery Management Council
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
FOSC	Federal On-Scene Coordinator
FR	Federal Register
FSB	Federal Subsistence Board
ft	foot/feet
ft ²	square foot/feet
FWPCA	Federal Water Pollution Control Act
FWS	Fish and Wildlife Service
G&G	geological and geophysical
gal	gallon(s)
GNP	Good Neighbor Policy
gpd	gallons per day
GTL	gas to liquid
HAP's	hazardous air pollutants
Hg	mercury
HgT	total mercury
Hz	Hertz
IAP	Integrated Activity Plan
ICAS	Inupiat Community of the Arctic Slope
IHA	Incidental Harassment Authorization
IMO	International Maritime Organization
in ³	cubic inch(es)
IPCC	Intergovernmental Panel on Climate Change

ISB	in-situ burn
ISC	Ice Seal Commission
ISER	Institute for Social and Economic Research
IWC	International Whaling Commission
IPF	impact-producing factor(s)
ITA	Incidental Take Authorization
ITL	Information to Lessees (Clauses)
ITM	Information Transfer Meeting
IUCN/SSG	World Conservation Union/Species Survival Commission
kHz	kilohertz
km	kilometer(s)
km ²	square kilometer(s)
kn	knot(s)
LA	Launch Area
LMR's	Land Management Regulations
LNG	liquefied natural gas
LOA	Letter of Authorization
LS	Land Segment
m	meter(s)
m ³	cubic meters
MARPOL	Marine Plastic Pollution Research and Control Act
MFCMA	Magnuson Fishery Conservation Management Act
mg/L	milligrams per liter
mi	mile(s)
mi ²	square mile(s)
mL	milliliter(s)
mm	millimeter(s)
MMbbl	million barrels
MMC	Marine Mammal Commission
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MOU	Memorandum of Understanding
MSA	Magnuson-Stevens Act
mph	miles per hour
m/s	meters per second
m ³ /s	cubic meters per second
MTRP	Marking, Tagging, and Reporting Program (FWS)
NAAQS	National Ambient Air Quality Standards
NC	Nanuk Commission
NEPA	National Environmental Protection Act
NFPMC	North Pacific Fisheries Management Council
ng/g	nanograms per gram
ng/L	nanogram per liter
NISA	National Invasive Species Act of 1996
NMFS	National Marine Fisheries Service
nmi	nautical mile(s)
NO _x	nitrogen oxides
NOAA	National Oceanographic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPR-A	National Petroleum Reserve in Alaska
NPS	National Park Service
NRC	National Research Council
NRP	National Response Plan
NSB	North Slope Borough
NSBMC	North Slope Borough Municipal Code
NSBSAC	North Slope Borough Science Advisory Committee
NSPS	New Source Performance Standards

NTAC's	Nondiscretionary Terms and Conditions
NTL	Notice to Lessees and Operators
NWAB	Northwest Arctic Borough
NWAFCA	Northwest Alaska Fisheries Center
O ³	ozone
OBC	ocean-bottom cable
OCRM	Ocean and Coastal Resource Management
OCS	Outer Continental Shelf
OPA/OPA-90	Oil Pollution Act of 1990
OSFR	Oil-Spill Financial Responsibility
OSRA	Oil-Spill-Risk Analysis
OSRO	oil-spill removal organizations
OSRP	Oil-Spill-Response Plan
OSRR	Oil-Spill Response Research
OSTLF	Oil Spill Liability Trust Fund
PAC's	polyaromatic compounds
PAH's	polycyclic aromatic hydrocarbons
PBR	Potential Biological Removal
PBSG	Polar Bear Specialist Group (IUCN/SSG)
PEA	Programmatic Environmental Assessment
P.L.	Public Law
PM	particulate matter
PM ₁₀	particulate matter less than 10 microns in diameter
PNOS	Proposed Notice of Sale
ppb	parts per billion
ppm	parts per million
PSD	Prevention of Significant Deterioration
psi	pounds per square inch
RCRA	Resource Conservation and Recovery Act
RD	Regional Director
rms	root mean-squared
ROD	Record of Decision
ROI	record of increase
ROW	right(s)-of-way
RP	Responsible Party or Recommended Practice
RPM's	Reasonably Prudent Measures
RS/FO	Regional Supervisor/Field Operations
RUSALCA	Russian-American Long-Term Census of the Arctic
SBI	Shelf Basin Interactions
SBS	southern Beaufort Sea stock of polar bears
SCC	Siberian Coastal Current
SDH	social determinants of health
SIP	State Implementation Plan
SLS	Spring Lead System
SO ₂	sulfur dioxide
SO ₄	sulfate
SOSC	State On-Scene Coordinator
SSSV	Subsurface Safety Valve
Sv	Sverdrup
TAPS	Trans-Alaska Pipeline System
Tcf	trillion cubic feet
Tcfg	trillion cubic feet of gas
TDS	total dissolved solids
TEK	Traditional Ecological Knowledge
TLH	Teshkepuk Lake (caribou) Herd
TSS	total suspended solids
TTS	temporary threshold shifts
UAA	University of Alaska, Anchorage

UAF	University of Alaska, Fairbanks
U.S.C.	United States Code
USCDC	U.S. Centers for Disease Control
USCG	U.S. Coast Guard
USDOC	U.S. Department of Commerce
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFDA	U.S. Food and Drug Administration
USGS	U.S. Geological Survey
UV	ultraviolet
VOC	volatile organic compounds
WAH	Western Arctic (caribou) Herd
WCD	worst-case discharge
WHB	Western Hudson Bay
WHO	World Health Organization
yd	yard(s)
yd ³	cubic yard(s)
2D	2-dimensional
3D	3-dimensional
°	degree(s)
°C	degrees Celsius
°F	degrees Fahrenheit
~	about
<	less than
>	greater than
≥	equal to or greater than
±	plus-minus
μ	micron
μg	microgram(s)
μg/m ₃	micrograms per cubicmeter

EXECUTIVE SUMMARY

Contents of Executive Summary

ES.1. Introduction and Background	ES-1
ES.2. Scoping and Draft EIS Public Comment	ES-2
ES.3. Hypothetical Development Scenario	ES-2
ES.4. Environmental Effects of the Proposed Action (Alternative I) for Lease Sale 193 and the Proposed Action (Alternative A) for Exploration Seismic Surveys	ES-3
ES.4.a. Effects from Routine Activities	ES-3
ES.4.b. Effects in the Event of a Large Oil Spill	ES-4
ES.4.c. Cumulative Effects	ES-6
ES.4.d. Alternative A (Exploration Seismic Surveys within the Entire Proposed Sale 193 Area)	ES-7
ES.5. Effects of Lease-Sale Alternatives II through IV and Exploration Seismic Survey Alternative B	ES-7
ES.6. Mitigation Measures	ES-9

EXECUTIVE SUMMARY

ES.1. Introduction and Background.

This environmental impact statement (EIS) examines a proposal for oil and gas leasing in the Chukchi Sea and three alternatives to this Proposed Action. This EIS also examines a proposal for exploration seismic-survey permitting in 2007 in the proposed sale area and two alternatives for the 2007 seismic surveys. This EIS addresses the potential impacts under the various alternatives and the potential mitigation measures associated with the Proposed Actions for leasing and associated exploration seismic-survey activity. The Proposed Action for the lease sale examined in the EIS is to offer for lease approximately 6,156 whole and partial blocks (about 34 million acres) identified as the program area in the 2002-2007 5-Year Program. The proposed Sale 193 area excludes a 15- to 50-mile(mi-)-wide corridor along the coast, the polynya or Spring Lead System. Water depths in the sale area vary from about 95 feet (ft) to approximately 262 ft. A small portion of the northeast corner of the area deepens to approximately 9,800 ft. The scenario assumed for environmental analysis involves the discovery, development, and production of the first offshore oil field in the Chukchi Sea. The Proposed Action for seismic surveying is to permit both prelease and postlease exploration seismic surveys within the entire proposed Sale 193 area. All permitted seismic surveys would be subject to the standard stipulations for Geological and Geophysical (G&G) permit activities (Sec. II.A.4), the measures to mitigate seismic-surveying effects (Sec. II.B.4.a), and the mitigation and monitoring requirements of the selected alternative (Alternative 6) from the *Final Programmatic Environmental Assessment (PEA), Arctic Ocean Outer Continental Shelf Seismic Surveys - 2006*, dated June 2006 (USDOI, MMS, 2006a) (Sec. II.B.4.b).

In 2002, the Secretary of the Interior issued the Final OCS Oil and Gas Leasing Program for 2002-2007. That document presented her decision to consider annual “special-interest” sales in the Chukchi Sea/Hope Basin OCS Planning Areas. The objective of this “special-interest” leasing option was to foster exploration in a frontier OCS area with potential oil and gas resources but that may have minimal industry interest because of high operating costs. The general approach for special-interest leasing was to query industry regarding the level of interest for proceeding with a sale in an area such as the Chukchi Sea/Hope Basin. We expected nominations of focused areas of specific industry interest or to offer such areas for lease. Based on the information and specific nominations received as a result of each Call for Interest and Nominations (Calls), a decision was made whether to proceed with the sale process.

We received no indication of interest in response to the first two Calls for special interest leasing in the Chukchi Sea/Hope Basin published in the *Federal Register (FR)* on March 25, 2003 (68 FR 14425), and January 30, 2004 (69 FR 4532); therefore, the process was stopped.

In response to the third Call published in the *Federal Register* on February 9, 2005 (70 FR 6903), industry nominated a substantial portion of the Planning Area. This area was greater than that envisioned in the special-interest lease-sale option described above. The MMS concluded that consideration of such a large area had merit in light of the significant resource potential of the area and the Administration’s goal to expedite exploration of domestic energy resources. The MMS further concluded that consideration of such a proposed action warranted a more extensive National Environmental Policy Act (NEPA) review than contemplated under the special interest leasing option.

With the publication of a Notice of Intent to Prepare an Environmental Impact Statement in the *Federal Register* on September 14, 2005 (70 FR 54406), MMS initiated the process to prepare a comprehensive “areawide” EIS for the so-designated Lease Sale 193. However, the EIS has not been completed in time to allow the Sale during the current 5-Year Program, which expires on June 30, 2007. Lease Sale 193 is tentatively scheduled for November 2007, subject to its retention in the next 5-Year Program for 2007-2012 and final adoption of the Program by the Secretary of the Interior.

The U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS) agreed to become a cooperating agency (as that term is defined in 40 CFR 1501.6) on this EIS to provide NEPA documentation for NMFS’ possible issuance of Letter of Authorization and Incidental Harassment Authorizations to the offshore oil and gas industry, principally the

seismic-survey industry, to take marine mammals by harassment, incidental to conducting prelease and ancillary on-lease oil and gas seismic surveys in the Chukchi Sea (see Sec. I.A.1, Regulatory Framework).

The Secretary's Proposed OCS Leasing Program for 2007-2012 includes an alternative for a 25-mi deferral in the Chukchi Sea Planning Area (USDO, MMS, 2006c:Fig. 2-1). An analysis for the 25-mi deferral can be found in the 2007-2012 5-Year Program EIS. A decision was made by the Secretary of the Interior (during the Sale 193 NEPA process) to adopt the 25-mi deferral in the final 2007-2012 5-Year Program. The result of this decision is to exclude from the proposed Sale 193 area a total of 129 whole or partial blocks representing approximately 534,668 acres (Fig. II.B-2). Alternatives III and IV also are slightly altered with the removal of six whole or partial blocks representing approximately 34,159 acres (Fig. II.B-3). The implementation of the 25-mi buffer by the Secretary does not change the existing impact analyses for the lease sale alternatives.

ES.2. Scoping and Draft EIS Public Comment.

Scoping is the ongoing public process to identify issues, alternatives, and mitigation measures to be considered for analysis in the EIS. Public scoping meetings were held in Wainwright, Point Hope, Point Lay, Barrow, and Anchorage, Alaska. 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 MMS identified the following major issues from the scoping comments:

- effects from accidental oil spills on the environment and the lack of effective oil-spill-response technology in the arctic environment;
- disturbance to bowhead whale-migration patterns from resulting activities;
- protection of subsistence resources and the Inupiat culture and way of life;
- habitat disturbances and alterations, including discharges and noise;
- oil and gas activity impacts are additive to impacts from climate changes;
- concerns over contamination of sediments, the water column, and the food chain that may be associated with offshore oil and gas development;
- lack of baseline data on resources in the Chukchi Sea Frontier Area, which limits credibility of the analysis on impacts to resources; and
- cumulative effects of past, present, and reasonably foreseeable future activities on the people and environment of Alaska's North Slope.

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.

ES.3. Hypothetical Development Scenario

The hypothetical scenario assumes that leasing and exploration by industry will be followed by development that is regulated by existing regulations. The scale of future activities will be controlled largely by industry perceptions of the Chukchi Sea program area relative to other worldwide exploration opportunities. Industry decisions primarily are influenced by their estimates of the petroleum potential, future market prices, and the regulatory regime. Individual companies could have widely varying views of these factors, and these views could change (positive or negative) through time. As stated previously, the scenario represents only one possible set of circumstances, and other hypothetical scenarios could be equally likely. For any scenario, the actual location and scale of offshore development will not be known for decades.

The scenario assumed for environmental analysis involves the discovery, development, and production of the first offshore oil field in the Chukchi Sea. It is assumed that all economic, engineering, and regulatory challenges can be overcome in a timely manner. Ultimately, recoverable oil resources from this field are assumed to be 1 billion barrels (Bbl), as lower oil volumes are not likely to be economic. If oil prices

drop below \$30.00 per barrel (they were above \$50.00 when this scenario was written), exploration in the Chukchi OCS is expected to be minimal and oil discoveries may not be developed. An “exploration only” scenario represents the status quo in this area, where discoveries are too small or costly for commercial development. As previously discussed, natural gas discoveries in the Arctic OCS are unlikely to be developed until a gas-transportation system from the North Slope to outside markets is operational and has the capacity to accept additional gas supplies from new fields. Other gas-transportation strategies (e.g., liquefied natural gas) were not considered to be as feasible or economically attractive as an overland pipeline system to U.S. markets.

To evaluate the leasing Alternatives, we introduce a concept called the “Opportunity Index.” This is a risk-weighted probability based on our analysis of resource potential. We use this concept to scale the likelihood that a commercial discovery will be made and development will occur in a particular broad subarea within the Chukchi Sea program area. To understand the Opportunity Index, suppose, for example, that an OCS area contained a total of 500 million barrels (MMbbl) of economically recoverable oil. From our resource assessment, we identify five likely prospects, each of the same size and equally likely to contain recoverable oil. The risk-weighted volume assigned to each prospect would be 100 MMbbl. 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 MMbbl could be discovered in any single prospect, but the others would be dry. If an area removed from leasing in one Alternative contained two of the five prospects, we would say that the Opportunity Index was reduced by 40%. Because we do not know how much oil is contained in any of these prospects, it would be inaccurate to say that 200 MMbbl is removed from the 500 MMbbl total in the sale area.

Outputs from geologic and economic assessment models based on currently available data define the Opportunity Index. These models assume that leasing, exploration, and development are not restricted by regulations or industry funding. In reality, access to untested tracts and exploration budgets constitute 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 and future corporate strategies for leasing are impossible to predict accurately. 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 an area such as the Chukchi Sea. The key concept is that industry will only bid on tracts that they believe have some chance of becoming viable oil and gas 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 Alternatives III and IV, which follow. Offering larger areas for leasing and exploration increases the likelihood that commercial discoveries will be made. But this is an opportunity, not a guarantee.

The hypothetical scenario outlines a feasible set of conditions to provide a framework for purposes of environmental analysis. Because development has not occurred in this area, it is optimistic to assume that historical trends will change in the next round of leasing and exploration. An optimistic development scenario ensures that the environmental analysis covers the potential effects of possible petroleum activities, including those that could occur as a result of higher oil prices or other incentives.

ES.4. Environmental Effects of the Proposed Action (Alternative I) for Lease Sale 193 and the Proposed Action (Alternative A) for Exploration Seismic Surveys.

ES.4.a. Effects from Routine Activities.

If the lease sale is held and exploration and development follows, the associated industrial activities would generate some degree of disturbance, noise, and discharges into the environment. The EIS analysis found that some potential significant effects from the anticipated routine, permitted activities may occur.

Potential effects from the lease sale would not cause any overall measurable degradation to the Chukchi Sea water quality. Effects to air quality from emissions would cause only small, local, and temporary increases in the concentration of criteria pollutants but would not cause ambient air quality standards to be exceeded. Effects to lower trophic-level organisms from disturbance caused by drilling platform emplacement and other effects from other routine operations would have moderate to low effects on local populations. Some measurable effect on fish resources would be likely. Some individual fish could be affected during construction and drilling activities; most fish in the immediate area would avoid these activities and would be otherwise unaffected. Seismic surveys, turbidity, and pipeline construction (both offshore and onshore) could cause adverse effects to essential fish habitat; however, the magnitude of impacts are considered low and are not expected to result in measurable effects at the regional ecosystem level.

Local effects could result on endangered species near noise and other disturbance caused by exploration, development, and production activities and disturbance from aircraft and vessels. Of particular concern is the bowhead whale. Concerns exist over impacts associated with “key habitat types” such as those used for calving, feeding, breeding, and resting, as well as those portions of the migratory pathway where the movements of the whales are constrained. Although small numbers of individuals could be affected, regional populations or migrant populations of nonendangered marine mammals (polar bears) and terrestrial mammals (brown bears, muskoxen, Arctic foxes, and others) could experience localized impacts. Wetlands and vegetation could experience adverse impacts onshore as a result of development activities but likely would not be impacted by the majority of the exploration activities. There is a high potential for marine and coastal birds to experience disturbance and habitat alteration. However, little recent site-specific data are available on habitat and use patterns, routes, and timing of specific species using the arctic environment.

Short-term, local disturbance could affect subsistence-harvest resources, but no resource or harvest area likely would become unavailable. Construction disturbance temporarily could displace a few individuals of subsistence species.

Sociocultural systems would not be altered, because the sale and possible followup activities would result in few new residents. Furthermore, the activities represent the continuation of an important and long-time aspect of many of the area’s communities. No “disproportionately high adverse effects,” as defined by the Environmental Justice Executive Order, are expected to occur from planned and permitted activities associated with the lease sale 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. In addition, terrestrial and marine archaeological surveys would identify any potential resources prior to activities taking place, and the sites would be avoided or the effects mitigated.

Based on the assumed discovery and development of 1 Bbbl of oil, some economic benefits could occur to the State of Alaska and the North Slope Borough. No conflicts are anticipated with the Statewide standards of the Alaska Coastal Management Plan or the enforceable policies of the North Slope Borough.

ES.4.b. Effects in the Event of a Large Oil Spill.

Over the life of the hypothetical development and production that could follow from the lease sale, other effects are possible from events, such as a large, accidental oil spill or natural gas release. We estimate the chance of a large spill greater than or equal to 1,000 bbl occurring and entering offshore waters is within a range of 33-51%. For purposes of analysis, we model one large spill of either 1,500 bbl (platform spill) or 4,600 bbl (pipeline spill).

If a large spill were to occur, the analysis identifies potentially significant impacts to bowhead whales, polar bears, essential fish habitat, marine and coastal birds, subsistence hunting, and archaeological sites. The realization of these impacts depends on species being in the relatively small area affected by the unlikely spill, seasonality, or contact by the oil in areas where hunting and archaeological resources occur. Evaluation of significance is done without regard to the effect of mitigating measures. However, the geographic response strategy for oil spills would require for measures to be employed to protect high-value resource areas in the unlikely event of a spill.

Water quality would be degraded temporarily, with the concentration of hydrocarbons in water less than the acute pollution criterion within 3 days of the spill, while concentration above the chronic criterion would last less than 30 days. Concentration of criterion pollutants for air quality would remain well within Federal air quality limits, with minimal effects to air quality. In the affected area of an oil spill, approximately 25 kilometers of tidal and subtidal sediments could be contaminated; populations of intertidal lower trophic-level organisms in these areas could be depressed measurably for about a year, and small amounts of oil would persist in the habitat for a decade.

While we expect no regionwide losses to fish resources at the population level, a potential loss could occur to some arctic fishes (including anadromous species) and would depend on the season and location of the spill; the life stage of the fishes (adult, juvenile, larval, or egg); and the duration of the oil contact. A large oil spill or chronic small spills impacting intertidal or estuarine spawning, rearing, and migration habitats used by early life-history stages of Pacific salmon are likely to result in significant adverse effects on local populations requiring three or more generations to recover to their former status. Impacts to these fish could result in loss of discrete population stocks. These salmon stocks would recover only by colonization by strays from nonaffected populations. While we estimate that effects to estuarine and marine essential fish habitat generally would be low because localized fish habitat would be expected to recover within months to years, effects on beach and intertidal fish habitats could be considered locally significant, because oil could remain in the small areas or prey could be impacted for more than a decade. Adverse but not significant effects (as defined under the NEPA) to endangered and threatened species usually would occur only when the species is present in the small area that would be affected at the time the unlikely spill occurs. For example, if an unlikely spill occurred in the Chukchi Sea during bowhead whale migration, the potential for there to be adverse effects likely would be greater if a large spill of fresh oil (with high concentrations of aromatics) contacted one or more large aggregation of bowheads, especially (but not exclusively) if such an aggregation contained large numbers of females and calves. Such aggregations occasionally have been documented in MMS aerial bowhead whale surveys. The likelihood of a large spill occurring and contacting such a group is low but not outside the range of possibility. Of particular concern are the spectacled and Steller's eiders. Some spectacled and Steller's eiders of the Alaskan breeding population could be greatly affected, if an unlikely spill occurred within the June to October timeframe.

Marine and coastal bird mortality could range from hundreds to tens of thousands, depending on the size, timing, and movement of the spill in relation to seasonal patterns of bird abundance and movement. Recovery for most species from these losses would take from 1 year to two or more generations.

Small numbers of resident nonendangered marine mammals, as well as polar bears, could be lost with total recovery from these losses taking place within 1-5 years and one or more generations for polar bears. No measurable effects to regional or migratory populations of marine mammals within the Chukchi Sea area are expected to occur. The estimated likely loss of terrestrial mammals could be 10 to hundreds of caribou and likely fewer than 10 individuals per species of muskoxen, grizzly bears, and arctic foxes. Regional populations of terrestrial mammals likely would not be affected.

Walrus are most vulnerable to the effects of an oil spill at coastal haulouts, particularly along the northern coast of Chukotka and Wrangel Island, where the preponderance of walrus using haulouts in the autumn are females and juveniles (Kochnev, 2004). There are nine major walrus haulouts along the coast of the Russian Chukchi Sea. Up to 125,000 walrus, mostly females with calves, have been estimated to use coastal haulouts on Wrangel Island in the Russian Arctic (Kochnev, 2004). Displacement from these crucial areas would likely result in population-level impacts on recruitment and survival. Walrus are long-lived animals with low rates of natural mortality and low rates of reproduction, which would severely limit the ability of the Pacific walrus population to recover from any adverse impacts associated with a large oil spill. An oil spill impacting these areas could have a significant impact on the Pacific walrus population.

There is uncertainty about effects on cetaceans in the event of a large spill. There are, in some years and in some locations, relatively large aggregations of feeding and molting whales within the proposed lease-sale area. If a large amount of fresh oil contacted a significant portion of such an aggregation, effects potentially could be greater than typically would be assumed; and we cannot rule out population-level effects, if a large number of females and newborn or very young calves were contacted by a large amount of fresh crude oil. Available information indicates it is unlikely that whales would be likely to suffer

significant population-level adverse effects from a large spill originating in the Chukchi Sea. However, individuals or small groups could be injured or potentially even killed in a large spill, and oil-spill-response activities (including active attempts to move whales away from oiled areas) could cause short-term changes in local distribution and abundance.

Recent information indicates that the Chukchi/Bering Sea polar bear stock likely is in decline due to illegal harvest in Russia (See Sec. III.B.6.c). This also means that the Maximum Sustained Yield, or the number of animals that can be sustainably removed from the population in any given year, also is reduced. Due primarily to increased concentrations of bears on parts of the coast, the potential for a large oil spill to impact polar bear populations has increased in recent years. This assessment concludes that the effects of a large oil spill, particularly during the broken-ice period, could pose significant risks to the polar bear population.

If an oil spill occurred close to the shoreline, the probability of adverse impacts to wetlands comprised of estuaries and saltmarshes would depend on wind and wave conditions. Oil deposition above the level of normal wave activity would occur, if the spill takes place during spring tides or during storm surges. In such case, oil stranded in emergent vegetation is expected to persist for long periods due to the low rates of dispersion and degradation.

A large oil spill likely could affect the local economy and create additional employment of 60-190 jobs for up to 6 months. The subsistence resources, including harvest areas and harvest patterns in traditional communities, could be affected for at least one harvest season or longer, with tainting concerns among consumers possibly making an even larger array of resources unavailable for use. Disruption of subsistence-harvest resources, such as that created by a large oil spill, would have predictable and significant consequences and could affect all aspects of sociocultural resources—social organization, cultural values, and institutional organization (Luton, 1985). Under Environmental Justice, a disproportionate high adverse effect on Alaskan Natives could result from the combination of an unlikely large spill contaminating essential subsistence-harvest areas, cleanup effects further damaging those resources, tainting concerns altering consumption of those resources, and disruption of subsistence practices as a result of the contamination. The sociocultural systems of towns and cities should not be affected by an unlikely large oil spill. Oil contamination and spill-cleanup activities that disturb significant archaeological resources that may be present in the area could result in potentially significant impacts. No adverse effects are anticipated to coastal management; the Statewide standards of the Alaska Coastal Management Plan; or the enforceable policies of the North Slope Borough.

In summary, a large oil spill could cause some adverse effects and a number of potentially significant effects. However, an area affected by such a spill relative to the size of the Chukchi Sea decreases the likelihood that the resources would be widely contacted by the spill.

ES.4.c. Cumulative Effects.

We do not expect any significant cumulative impacts to result from any of the routine activities associated with Alternative I for Sale 193. For the cumulative analysis in this EIS, we estimate that the effects of the other alternatives (Alternatives III and IV) for Sale 193, if chosen, would be essentially the same as those for Alternative I for Sale 193. In the cumulative effects analysis, we assess the estimated contribution of Sale 193 to the combined estimated additive, countervailing, and synergistic effects of all the past, present, and reasonably foreseeable activities that are likely to affect the same resources that may be affected by Sale 193. The differences in effects between the proposed sales and their alternatives are so small that we cannot distinguish measurable differences between the combined estimated effects in the cumulative case analysis.

If the routine activities associated with scenarios developed for Alternative I for Sale 193 occurred, the incremental contribution from the activities to the cumulative effects likely would account for a large majority of the impacts in the Chukchi Sea as a result of it being a frontier area. We estimate the activities would contribute directly to the majority of the cumulative effects in Chukchi Sea from offshore oil exploration and development, based on the lack of existing production within this frontier area. The analysis did find potential significant local cumulative effects to some fish, marine and coastal birds from a variety of sources, and archaeological resources (if significant resources are affected) from onshore development. In the unlikely event a large or very large oil spill occurred and contacted resources,

significant cumulative effects could be experienced. For biological resources, effects on marine and coastal birds would be through increased recovery time. For beach and intertidal essential fish habitat, effects would be from the persistence of oil. For endangered and threatened species, effects would be from spill contact with bowhead whales, spectacled eiders and their critical habitat, or Steller's eiders. In the unlikely event a large oil spill occurred and contacted subsistence resources, significant cumulative effects could be experienced. For subsistence-harvest resources and the linked sociocultural systems and Environmental Justice, effects would result from spill contact to subsistence resources, cleanup activities, and the fear that resources were tainted. Significant damage could occur to archaeological resources from contact or cleanup activities.

ES.4.d. Alternative A (Exploration Seismic Surveys within the Entire Proposed Sale 193 Area).

All permitted seismic surveys would be subject to the standard stipulations for G&G permit activities (Sec. II.B.4), the measures to mitigate seismic-surveying effects (Sec. II.B.4.a), and the mitigation and monitoring requirements of the selected alternative (Alternative 6) from the *Final Programmatic Environmental Assessment (PEA) Arctic Ocean Outer Continental Shelf Seismic Surveys - 2006*, dated June 2006 (USDO, MMS, 2006a) (Sec. II.B.4.b). Exploration seismic surveys with requirements are included in the scenarios for Sale 193 Alternatives I, III, and IV. The potential effects of such seismic surveys are evaluated in the impact analyses presented in Section IV.C.1.

ES.5. Effects of Lease-Sale Alternatives II through IV and Exploration Seismic Survey Alternative B.

ES.5.a. Lease Sale Alternative II through IV

In addition to Alternative II (No Lease Sale), two deferral alternatives were identified during the scoping process for analysis in the EIS. These alternatives are evaluated as options for proposed Lease Sale 193. Although Alternatives III (Corridor I Deferral) and IV (Corridor II Deferral) provide limited 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 this Executive Summary for any of the sales.

Alternative II (No Lease Sale) equals cancellation of Sale 193. Several individuals suggested this alternative during scoping. If proposed Sale 193 is cancelled, neither the estimated possible oil and gas production nor the potential environmental effects resulting from the Proposed Action would occur. From a regional perspective, canceling the sale would provide some protection to the environmental resources in the Chukchi Sea, but likely would not completely eliminate environmental impacts associated with climate change and other environmental and anthropogenic factors. Under this alternative, the leasing actions proposed in the Chukchi Sea multiple-sale EIS would not be approved. Should this occur, there would be no leases offered in the Chukchi Sea through 2007, and no oil and gas would be developed from this offshore area. If the estimated 1 Bbbl of oil is not produced, there would be no risk for oil spills and no effects to the flora and fauna either on- or offshore the Chukchi Sea coast. There would be no noise, habitat disturbance and alteration, or water discharges and air emissions from the activities associated with exploration and development/production operations. Substantial economic benefits, including direct income to the Federal Government (bonus bids, rental, royalties, and corporate taxes), to the State and local governments (property taxes, corporate income taxes), and both direct and indirect income to individuals (salaries) and businesses (fees for services and supplies) would be lost.

From a global perspective, assuming that the amount of oil resources used in the U.S. continues at current rates, oil production in foreign countries would need to increase, with increased transportation by tanker to the U.S. Therefore, if the sale is cancelled, the environmental consequences described under Alternative I would not occur in the Chukchi, but the production and transportation of the replacement oil would cause a variety of environmental consequences elsewhere. Imported oil imposes negative environmental impacts in producing countries and in countries along transportation routes. By not producing our own domestic oil and gas resources and relying on imported oil we are, from a global perspective at least, exporting a sizeable portion of the environmental impacts to those countries from which the U.S. imports oil and

through or by which our imported oil is transported. This same transfer of environmental consequences holds true for any oil not produced, if either or both of the deferral alternatives are chosen.

Alternative III (Corridor I) is the Proposed Action excluding an area comprising approximately 1,649 whole or partial blocks along the coastward edge of the sale area as identified in the Area ID (Map 2). This alternative would attempt to reduce potential impacts to subsistence hunting as well as various wildlife species and associated habitats.

The MMS developed this alternative based on a combination of deferrals identified in the scoping process including subsistence hunting areas for bowhead, beluga, and walrus, location of critical habitat for the endangered spectacled and Steller's eiders, and in response to comments received during scoping. In part, this deferral was developed as a potential way to reduce conflicts between subsistence users and offshore oil and gas operations, based on input from the North Slope Borough and others and analysis of subsistence resource use patterns. The EIS analysis concluded that the deferral would reduce potential impacts to endangered and threatened species, including the spectacled and Steller's eiders, Kittlitz's murrelets (a candidate species), and bowhead whales; reduce threats to marine and coastal birds because of their concentration in the deferral area; reduce visual-resource effects by moving the potential platform locations farther offshore; and protect possible unidentified historic archaeological resources that may be present in the deferral area. The EIS analysis concludes that for most resources, while the alternative would provide a measure of protection to the resources within the deferral area, the effects to the resources in the Chukchi Sea area under this alternative would be essentially the same as the effects under Alternative I. As shown by the Lost Opportunity Index information in Section IV.A.2.a., this deferral reduces the Opportunity Index by approximately 36%; that is, the chance is lower that a large oil field will be discovered and developed as a result of offering leases in a smaller sale area.

Alternative IV (Corridor II) is the Proposed Action excluding an area comprising approximately 795 whole or partial blocks along the coastward edge of the sale area as identified in the Area ID (Map 3). This alternative was developed as a result of the 1987 Biological Opinion for the Chukchi Sea as recommended by NMFS.

The MMS developed this alternative based on the latest Biological Opinion from NMFS in 1987. The 1987 Biological Opinion primarily focused on the spring lead system for protecting migrating bowhead whales. The EIS analysis concluded that the deferral would reduce potential impacts to endangered and threatened species, including the bowhead whale, and other whales; reduce threats to marine and coastal birds because of their concentration in the deferral area; and reduce visual resource effects by moving the potential platform locations farther offshore. The analysis concludes that for most resources, although the alternative would provide a measure of protection to the resources within the deferral area, the effects to the resources in the Chukchi Sea area under this alternative would be essentially the same as the effects under Alternative I. As shown by the Lost Opportunity Index information found in Section IV.A.2.a., this deferral reduces the Opportunity Index by approximately 15%; that is, the chance is lower that a large oil field will be discovered and developed as a result of offering leases in a smaller sale area.

If the Secretary of the Interior decides to proceed with proposed Lease Sale 193 (i.e., does not choose Alternative II, No Lease Sale), the Secretary may choose one, all, some combination, or part of any of the alternatives to comprise the area offered for sale in the Final Notice of Sale for Sale 193. The Secretary will have all the options available for Sale 193 when that decision is made in 2007.

ES.5.b. Alternative B (Prohibit Pre-Sale 193 Exploration Seismic Surveys in the Corridor II Deferral Area).

This alternative to the Proposed Action for seismic surveys (Alternative A) would prohibit pre-Sale 193 exploration seismic surveys in the 795 whole or partial blocks in Corridor II Deferral area (Alternative IV) along the coastward edge of the proposed Sale 193 area. The Corridor II Deferral area was developed from the recommended conservation measures in the 1987 Biological Opinion from NMFS. The southern end of the corridor was expanded to encompass a portion of the Ledyard Bay Critical Habitat Area that lies within the proposed Sale 193 area. Prohibiting pre-Sale 193 seismic surveys in this area would eliminate potential direct impacts from seismic surveys in this area during 2007, including the presence of seismic-source

vessels and potential space-use conflicts. Prohibiting pre-Sale 193 seismic surveys in this area would reduce potential noise disturbance to coastal resources and activities during 2007. These potential impacts are described in the proposed sale action analyses in Section IV.C.1.

Prohibiting pre-Sale 193 seismic surveys in this area would defer seismic surveys in this area until the Sale 193 decisions are made. If this area is deferred from leasing in Sale 193, then little seismic surveying would be expected to be proposed in this area. Some of the original Corridor II Deferral Area has already been deferred from leasing in the 2007-2012 5-Year Program. If Corridor II is deferred from Sale 193, no ancillary activities would occur in the area.

Prohibiting pre-Sale 193 seismic surveys in this area would defer seismic surveys in this area until the NMFS/MMS Seismic Survey Programmatic EIS and a record of decision have been completed.

ES.6. Mitigation Measures.

Mitigation measures have been proposed, identified, evaluated, or developed through previous MMS lease-sale NEPA review and analysis processes. Many of these mitigation measures have been adopted and incorporated into regulations and guidelines governing OCS exploration, development, and production activities. All plans for OCS activities go through MMS review and approval to ensure compliance with established laws and regulations. Mitigation measures must be incorporated and documented in plans submitted to MMS. Operational compliance is enforced through the MMS on-site inspection program.

Seven standard lease stipulations are evaluated as part of all the alternatives for the proposed lease sale.

1. Protection of Biological Resources
2. Orientation Program
3. Transportation of Hydrocarbons
4. Industry Site-Specific Monitoring for Marine Mammal Subsistence Resources
5. Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvest Activities
6. Pre-Booming Requirements for Fuel Transfers
7. Measures to Minimize Effects to Spectacled and Steller's Eiders from Exploration Drilling

Combined, these stipulations help lower the potential adverse effects of the proposed lease sale and, in particular, help protect subsistence-harvest activities and sociocultural systems. These measures are perceived as positive actions under Environmental Justice addressing impacts to minority populations.

Twenty four Information to Lessees (ITL) clauses would apply to OCS activities in the Chukchi Sea. The primary purpose an ITL is to provide lessees with additional information related to mitigating potential adverse impacts from future oil and gas activities. Some ITL's provide information about issues and concerns related to particular environmental or sociocultural resources. Some ITL's provide information on how lessees might plan their activities to meet MMS requirements or reduce potential impacts. Some ITL's provide information about the requirements or mitigation required by other Federal and State agencies. To the extent that the ITL clauses alert and inform lessees and their contractors about mitigative measures, the ITL clauses are effective in lowering potential impacts. For analysis purposes, they are considered part of the Proposed Action and alternatives for the Chukchi Sea Sale 193.

- No. 1 – Information on Community Participation in Operations Planning
- No. 2 – Information on Bird and Marine Mammal Protection
- No. 3 – Information on River Deltas
- No. 4 - Information on Endangered Whales and MMS Monitoring Program
- No. 5 – Information on the Availability of Bowhead Whales for Subsistence-Hunting Activities
- No. 6 – Information on High-Resolution Geological and Geophysical Survey Activity
- No. 7 – Information on the Spectacled Eider and Steller's Eider
- No. 8 – Information on Sensitive Areas to be Considered in Oil-Spill-Contingency Plans
- No. 9 – Information on Coastal Zone Management
- No. 10 – Information on Navigational Safety

- No. 11 – Information on Offshore Pipelines
- No. 12 – Information on Discharge of Produced Waters
- No. 13 – Information on Use of Existing Pads and Islands
- No. 14 – Information on Planning for Protection of Polar Bears
- No. 15 – Possible listing of Polar Bear under ESA
- No. 16 – Archaeological and Geological Hazards Reports and Surveys
- No. 17 – Response Plans for Facilities Located Seaward of the Coast Line
- No. 18 – Oil Spill Financial Responsibility for Offshore Facilities
- No. 19 – Good Neighbor Policy
- No. 20 – Rentals/Minimum Royalties and Royalty Suspension Provisions
- No. 21 – MMS Inspection and Enforcement of Certain Coast Guard Regulations
- No. 22 – Statement Regarding Certain Geophysical Data
- No. 23 – Affirmative Action Requirements
- No. 24 – Bonding Requirements

Eighteen standard stipulations (1 through 18) are evaluated as part of the seismic survey activities authorized by MMS through the G&G permitting process under regulations at 30 CFR 251. In addition, the following requirements are assumed to be in place for any seismic surveying related to proposed Sale 193:

1. Seismic surveys must not occur in the Chukchi Sea Spring Lead System before July 1, unless authorized by NMFS, to provide bowhead cow/calf pairs additional protection.
2. Seismic-survey activities are not permitted within the Ledyard Bay spectacled eider critical-habitat area.
3. Seismic-survey support aircraft must avoid overflights of Ledyard Bay critical-habitat area after July 1, unless aircraft are at an altitude in excess of 1,500 feet or human safety requires deviation (e.g., a medical emergency).

Combined, these stipulations help lower the potential adverse effects of any proposed seismic surveys and, in particular, help protect subsistence-harvest activities and sociocultural systems. These measures are perceived as positive actions under Environmental Justice addressing impacts to minority populations.

The EIS also provides consideration and a summary of the alternative mitigation measures for seismic surveying that were evaluated in the recently completed *Programmatic Environmental Assessment of Arctic Ocean Outer Continental Shelf Seismic Surveys – 2006* (USDOI, MMS, 2006a).

**TABLE
OF
CONTENTS**

TABLE OF CONTENTS

I.	THE PROPOSED ACTION	I-1
I.A.	Purpose and Need for the Proposed Action	I-1
I.B.	Description of the Proposed Action	I-2
I.C.	Regulatory and Administrative Framework	I-3
I.D.	Prelease Process	I-9
I.E.	Postlease Processes	I-10
II.	ALTERNATIVES INCLUDING THE PROPOSED ACTION	II-1
II.A.	Lease Sale 193 National Environmental Policy Act Analysis	II-1
II.B.	Alternatives, Mitigation Measures, and Issues	II-1
II.C.	Proposed Chukchi Sea Lease Sale	II-32
II.C.1.	Alternative I – Proposed Action	II-32
II.C.2.	Alternative II – No Lease Sale	II-40
II.C.3.	Alternative III – Corridor I Deferral	II-40
II.C.4.	Alternative IV – Corridor II Deferral (Agency Preferred Alternative)	II-43
III.	DESCRIPTION OF THE AFFECTED ENVIRONMENT	III-1
III.A.	Physical Environment	III-1
III.A.1.	Quaternary Geology	III-1
III.A.2.	Climate and Meteorology	III-6
III.A.3.	Physical Oceanography	III-8
III.A.4.	Sea Ice	III-11
III.A.5.	Water Quality	III-17
III.A.6.	Air Quality	III-19
III.A.7.	Acoustic Environment	III-21
III.B.	Biological Environment	III-27
III.B.1.	Lower Trophic-Level Organisms	III-27
III.B.2.	Fish Resources	III-31
III.B.3.	Essential Fish Habitat	III-42
III.B.4.	Threatened and Endangered Species	III-44
III.B.4.a.	Threatened and Endangered Marine Mammals	III-44
III.B.4.b.	Threatened and Endangered Marine and Coastal Birds	III-61
III.B.5.	Marine and Coastal Birds	III-61
III.B.6.	Other Marine Mammals	III-70
III.B.7.	Terrestrial Mammals	III-86
III.B.8.	Vegetation and Wetlands	III-89
III.C.	Social Systems	III-92
III.C.1.	Economy	III-92
III.C.2.	Subsistence-Harvest Patterns	III-94
III.C.3.	Sociocultural Systems	III-116
III.C.4.	Archaeological Resources	III-122
III.C.5.	Land Use Plans and Coastal Management program	III-125
III.C.6.	Environmental Justice	III-128

IV. ENVIRONMENTAL CONSEQUENCES, IV-1

- IV.A. Basic Assumptions for Effects Assessment **IV-1**
- IV.B. Alternative II – No Lease Sale **IV-23**
- IV.C. Analysis of Effects of Chukchi Sea Oil and Gas Development **IV-26**
 - IV.C.1. Alternative I – Proposed Action **IV-26**
 - IV.C.1.a. Water Quality **IV-26**
 - IV.C.1.b. Air Quality **IV-38**
 - IV.C.1.c. Lower Trophic-Level Organisms **IV-45**
 - IV.C.1.d. Fish Resources **IV-51**
 - IV.C.1.e. Essential Fish Habitat **IV-74**
 - IV.C.1.f. Threatened and Endangered Species **IV-80**
 - IV.C.1.f(1) Threatened and Endangered Marine Mammals **IV-80**
 - IV.C.1.f(2) Threatened and Endangered Marine and Coastal Birds **IV-125**
 - IV.C.1.g. Marine and Coastal Birds **IV-125**
 - IV.C.1.h. Other Marine Mammals **IV-145**
 - IV.C.1.i. Terrestrial Mammals **IV-172**
 - IV.C.1.j. Vegetation and Wetlands **IV-178**
 - IV.C.1.k. Economy **IV-183**
 - IV.C.1.l. Subsistence-Harvest Patterns **IV-185**
 - IV.C.1.m. Sociocultural Systems **IV-234**
 - IV.C.1.n. Archaeological Resources **IV-240**
 - IV.C.1.o. Land Use Plans and Coastal Management Programs **IV-243**
 - IV.C.1.p. Environmental Justice **IV-253**
 - IV.C.2. Alternative III (Corridor I Deferral) **IV-267**
 - IV.C.2.a. Water Quality **IV-267**
 - IV.C.2.b. Air Quality **IV-267**
 - IV.C.2.c. Lower Trophic-Level Organisms **IV-267**
 - IV.C.2.d. Fish Resources **IV-268**
 - IV.C.2.e. Essential Fish Habitat **IV-268**
 - IV.C.2.f. Threatened and Endangered Species **IV-268**
 - IV.C.2.f(1) Threatened and Endangered Marine Mammals **IV-268**
 - IV.C.2.f(2) Threatened and Endangered Marine and Coastal Birds **IV-269**
 - IV.C.2.g. Marine and Coastal Birds **IV-269**
 - IV.C.2.h. Other Marine Mammals **IV-269**
 - IV.C.2.i. Terrestrial Mammals **IV-269**
 - IV.C.2.j. Vegetation and Wetlands **IV-270**
 - IV.C.2.k. Economy **IV-270**
 - IV.C.2.l. Subsistence-Harvest Patterns **IV-270**
 - IV.C.2.m. Sociocultural systems **IV-271**
 - IV.C.2.n. Archaeological Resources **IV-271**
 - IV.C.2.o. Land Use Plans and Coastal Zone Management **IV-271**
 - IV.C.2.p. Environmental Justice **IV-271**
 - IV.C.3. Alternative IV (Corridor II Deferral) (Agency-Preferred Alternative) **IV-272**
 - IV.C.3.a. Water Quality **IV-272**
 - IV.C.3.b. Air Quality **IV-272**
 - IV.C.3.c. Lower Trophic-Level Organisms **IV-272**
 - IV.C.3.d. Fish Resources **IV-273**
 - IV.C.3.e. Essential Fish Habitat **IV-273**
 - IV.C.3.f. Threatened and Endangered Species **IV-273**
 - IV.C.3.f(1) Threatened and Endangered Marine Mammals **IV-273**
 - IV.C.3.f(2) Threatened and Endangered Marine and Coastal Birds **IV-274**
 - IV.C.3.g. Marine and Coastal Birds **IV-274**
 - IV.C.3.h. Other Marine Mammals **IV-274**
 - IV.C.3.i. Terrestrial Mammals **IV-274**
 - IV.C.3.j. Vegetation and Wetlands **IV-274**
 - IV.C.3.k. Economy **IV-275**
 - IV.C.3.l. Subsistence-Harvest Patterns **IV-275**

IV.C.3.m.	Sociocultural Systems	IV-275
IV.C.3.n.	Archaeological Resources	IV-276
IV.C.3.o.	Land Use Plans and Coastal Zone Management	IV-276
IV.C.3.p.	Environmental Justice	IV-276
IV.C.4.	Alternative A (Exploration Seismic Surveys within the Entire Proposed Sale 193 Area)	IV-277
IV.C.5.	Alternative B (Prohibit Pre-Sale 193 Exploration Seismic Surveys in the Corridor II Deferral Area)	IV-277
IV.D.	Unavoidable Adverse Effects	IV-277
IV.E.	Relationship Between Local Short-Term Uses and Maintenance and Enhancement of Long-Term Productivity	IV-281
IV.F.	Irreversible and Irrecoverable Commitment of Resources	IV-285
V.	CUMULATIVE EFFECTS	V-1
V.A.	Introduction and General Conclusions	V-1
V.B.	Activities We Considered in this Cumulative-Effects Analysis	V-4
V.C.	Analysis of Cumulative Effects	V-11
V.C.1.	Water Quality	V-14
V.C.2.	Air Quality	V-15
V.C.3.	Lower Trophic-Level Organisms	V-17
V.C.4.	Fish Resources	V-17
V.C.5.	Essential Fish Habitat	V-18
V.C.6.	Threatened and Endangered Species	V-18
V.C.6.a.	Threatened and Endangered Marine Mammals	V-18
V.C.6.b.	Threatened and Endangered Marine and Coastal Birds	V-30
V.C.7.	Marine and Coastal Birds	V-30
V.C.8.	Other Marine Mammals	V-31
V.C.9.	Terrestrial Mammals	V-40
V.C.10.	Vegetation and Wetlands	V-41
V.C.11.	Economy	V-43
V.C.12.	Subsistence-Harvest Patterns	V-45
V.C.13.	Sociocultural Systems	V-68
V.C.14.	Archaeological Resources	V-69
V.C.15.	Environmental Justice	V-70
VI.	CONSULTATION AND COORDINATION	VI-
VI.A.	Development of the Proposal	VI-1
VI.B.	Development of the EIS	VI-1
VI.C.	Review of the Draft EIS	VI-2
VI.D.	Consultation	VI-7

SECTION I

THE PROPOSED ACTION

Contents of Section I

I.A. Purpose and Need for the Proposed Action I-1

I.B. Description of the Proposed Action I-2

I.C. Regulatory and Administrative Framework I-3

I.C.1. The Outer Continental Shelf Lands Act I-3

I.C.2. The National Environmental Policy Act and the Council on Environmental Quality I-3

I.C.3. The Marine Mammal Protection Act I-3

I.C.4. The Magnuson Fishery Conservation and Management Act of 1976 I-4

I.C.5. The Endangered Species Act I-4

I.C.6. The Oil Pollution Act I-5

I.C.7. The Clean Water Act I-5

I.C.8. The Clean Air Act I-5

I.C.9. The Resource Conservation and Recovery Act I-6

I.C.10. The Marine Plastic Pollution Research and Control Act I-6

I.C.11. The Coastal Zone Management Act I-6

I.C.12. Executive Order 12898 – Environmental Justice I-7

I.C.13. Executive Order 13112 – Aquatic Invasive Species I-7

I.C.14. Executive Order 13212 – Actions to Expedite Energy-Related Projects I-8

I.C.15. Executive Order 13175 – Consultation and Coordination with Indian Tribal Governments I-8

I.C.16. MMS Regulations I-8

I.C.17. Other Applicable Laws and Regulations I-9

I.D. Prelease Process I-9

I.E. Postlease Process I-10

I.E.1. Geological and Geophysical Exploration Permits I-11

I.E.2. Exploration Plans, and Development and Production Plans I-11

I.E.3. Archaeological Resources Protection I-11

I.E.4. Applications for Permits to Drill I-11

I.E.5. Best Available and Safest Technology Requirements I-11

I.E.6. MMS Technical and Safety Review I-11

I.E.7. Pipeline Regulations I-12

I.E.8. Oil-Spill-Response Plans I-12

I.E.9. Discharge and Pollution Regulations I-12

I.E.10. Structure Removal and Site Clearance I-13

I.E.11. MMS Inspection Program I-8

I.E.12. Training Requirements for Offshore Personnel I-13

I.F. Important Differences between the Draft EIS and the Final EIS I-13

I. THE PROPOSED ACTION

I.A. Purpose and Need for the Proposed Action.

The purpose of the proposed Federal actions addressed in this Environmental Impact Statement (EIS) is to (1) offer for lease areas in the Chukchi Sea Outer Continental Shelf (OCS) that might contain economically recoverable oil and gas resources and (2) provide analyses for exploration seismic-survey activities. This lease sale would provide qualified bidders the opportunity to bid on certain blocks in the Chukchi Sea OCS to gain conditional rights to explore, develop, and produce oil and natural gas. This EIS is the National Environmental Policy Act (NEPA) analysis to enable Minerals Management Service (MMS) to make informed decisions on the configuration of the lease sale and the applicable mitigation measures for both lease activities and seismic surveys.

The President's National Energy Policy recommends conducting the OCS oil and gas leasing on a predictable schedule. Domestic energy production is not expected to increase 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.

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 (USDO) 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 purposes with respect to managing OCS resources. Those purposes 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 MMS as the administrative agency responsible for the minerals leasing of submerged OCS lands and for the supervision of offshore operations after leases are issued.

This EIS addresses the proposed Federal action known as Chukchi Sale 193 as included in the Final Outer Continental Shelf Oil and Gas Leasing Program 2002-2007 approved by the Secretary on June 30, 2002. With the publication of a Notice of Intent to Prepare an Environmental Impact Statement in the *Federal Register (FR)* on September 14, 2005 (70 *FR* 54406), MMS initiated the process to prepare a comprehensive "areawide" EIS for Sale 193. However, the prelease and the NEPA/EIS processes will not be completed in time to allow the sale during the current 5-Year Program, which expires on June 30, 2007. Sale 193 is scheduled for February 2008, subject to final adoption of the Program by the Secretary of the Interior. This EIS analyzes the potential environmental impacts of activities associated with the lease sale, including estimated exploration and development and production activities that may result from the sale, on the physical, biological, and human environments.

If commercial discoveries are found and developed, crude oil production would be expected as a result of the proposed lease sale. The Chukchi Sea OCS is viewed as one of the most petroleum-rich offshore provinces in the country, with geologic plays extending offshore from some of the largest oil and gas fields on Alaska's North Slope.

This EIS provides environmental impact evaluation of activities associated with proposed Chukchi Sea Sale 193. In accordance with Council on Environmental Quality (CEQ) regulations and guidelines, MMS

intends that further analysis of specific proposed activities will tier from this EIS and that the information and evaluation in this EIS will be incorporated by reference in the proposal-specific environmental reviews.

This EIS provides the NEPA documentation in support of MMS's permitting process and regulatory authority for Chukchi Sea geophysical permits for seismic surveys and geophysical and scientific research under MMS regulations 30 CFR 250 and 30 CFR 251. Seismic surveying is a method of collecting data on the geology below the seafloor by generating sound waves and recording the sound reflected back from the rock and sediment layers. Three-dimensional (3D) and two-dimensional (2D) exploration seismic surveys are done both before a lease sale (prelease) to provide information that is used by industry and government to evaluate the potential for offshore oil and gas resources and after a lease sale (postlease) to further delineate potential hydrocarbon reservoirs and to prepare for future lease sales. The MMS will conduct a separate review of individual permit application to ensure that specific proposed seismic surveying are within the range of activities evaluated in this EIS and to determine whether further NEPA evaluation is necessary.

This EIS provides the NEPA documentation in support of MMS's review and decisionmaking for Exploration Plans submitted under regulatory authority at 30 CFR 250. The MMS will prepare an Environmental Assessment (EA) tiered from and incorporating by reference the analysis in this EIS for individual Exploration Plans (EP's) to determine whether additional NEPA evaluation is necessary. This EIS also provides the NEPA documentation in support of on-lease ancillary activities, including high-resolution site-clearance seismic surveying, as defined in MMS operating regulations at 30 CFR 250.

This EIS will provide NEPA documentation for the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service's (NMFS) possible issuance of Letters of Authorization (LOA's) and Incidental Harassment Authorizations (IHA's) to the offshore oil and gas industry, principally the seismic-survey industry, to take marine mammals by harassment, incidental to conducting prelease and ancillary on-lease oil and gas seismic surveys in the Chukchi Sea (see Sec. I.A.1 Regulatory Framework). To address its NEPA responsibilities, NMFS agreed to become a cooperating agency (as that term is defined in 40 CFR 1501.6) and proposes to adopt this EIS as authorized by 40 CFR 1506.3 as its own NEPA statement.

I.B. Description of the Proposed Action.

The Secretary has scheduled Chukchi Sea Sale 193 to be held in 2008. The resource estimates and scenario information included in this EIS analysis is presented as a range of activities that could be associated with the sale.

The Proposed Sale Action examined in the EIS is to offer for lease approximately 6,156 whole and partial blocks (about 34 million acres) identified as the program area in the 2002-2007 5-Year Program. The proposed Sale 193 area excludes a corridor along the coast, up to approximately 50 miles (mi), the polynya or spring lead system. Water depths in the majority of the sale area vary from about 95 feet (ft) to approximately 262 ft. A small portion of the northeast corner of the area deepens to approximately 9,800 ft.

A description of proposed exploration seismic-survey activities is included within this document to provide the public an opportunity to solicit comments through scoping and public hearings. Alternatives associated with the exploration seismic surveys was analyzed in the Programmatic Environmental Assessment (PEA) *Arctic Ocean Outer Continental Shelf Seismic Surveys – 2006* (USDOI, MMS, 2006a) and information from the PEA is updated in this document. The decision process for choosing a mitigation alternative associated with the exploration seismic-survey activity is separate from the decision associated with selecting a lease-sale alternative. Therefore, exploration seismic-survey activity may occur whether or not proposed Lease Sale 193 occurs. Impacts associated with exploration seismic-survey activity are the same for all alternatives analyzed in this document.

I.C. Regulatory and Administrative Framework.

Federal regulations mandate the OCS leasing program and the environmental review process. Several Federal regulations establish specific consultation and coordination processes with Federal, State, and local agencies. In addition, the OCS leasing process and all activities and operations on the OCS must comply with other Federal, State, and local laws and regulations. The following are summaries of some of the applicable laws and regulations.

I.C.1. The Outer Continental Shelf Lands Act.

Under the OCS Lands Act, the Department of the Interior is required to manage the orderly leasing, exploration, development, and production of oil and gas resources on the Federal OCS, while simultaneously ensuring the protection of the human, marine, and coastal environments; that the public receives a fair and equitable return for these resources; and that free market competition is maintained. The OCS Lands Act requires coordination with the affected States and, to a more limited extent, local governments. At each step of the procedures that lead to lease issuance, participation from the affected States and other interested parties is encouraged and sought.

I.C.2. The National Environmental Policy Act and the Council on Environmental Quality.

The NEPA requires that all Federal Agencies use a systematic, interdisciplinary approach to protection of the human environment; this approach will ensure the integrated use of the natural and social sciences in any planning and decisionmaking that may have an impact on the environment. The NEPA also requires preparation of a detailed EIS on any major Federal action that may have a significant impact on the environment. This EIS must include any adverse environmental effects that cannot be avoided or mitigated, alternatives to the Proposed Action, the relationship between short-term uses and long-term productivity of the environment, and any irreversible and irretrievable commitments of resources. In 1979, the CEQ established uniform procedures for implementing the procedural provisions of NEPA. These regulations provide for the use of the NEPA process to identify and assess the alternatives to proposed actions that avoid and minimize adverse effects of these actions on the quality of the human environment. "Scoping" is used to identify the scope and significance of important environmental issues associated with a proposed Federal action through coordination with Federal, State, and local agencies; the public; and any interested individual or organization prior to the development of an impact statement. The process also identifies and eliminates from further detailed study issues that are not significant or that have been covered by prior environmental review.

I.C.3. The Marine Mammal Protection Act.

Under the Marine Mammal Protection Act (MMPA) (16 U.S.C. § 1371; 50 CFR, Subpart 1), the taking of marine mammals without a permit or exemption from NMFS is prohibited. The term "take" under the MMPA means "to harass, hunt, capture, kill, or collect, or attempt to harass, hunt, capture, kill or collect." The NMFS has further defined takes by "harassment" into two types: (1) Level A Harassment as "any act of pursuit, torment, or annoyance, which has the potential to injure a marine mammal or marine mammal stock in the wild" and (2) Level B Harassment as "any act of pursuit, torment, or annoyance, which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavior patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild." To date, NMFS' policy has been to use the 180 decibel (dB) root-mean-squared (rms) isopleth for cetaceans and 190-dB rms isopleth for pinnipeds to indicate where Level A harassment from acoustic sources begins. In addition, NMFS uses the 160-dB rms isopleth to indicate where Level B harassment begins for acoustic sources, including impulse sounds, such as used for seismic surveying.

In order to obtain an exemption from the MMPA's prohibition on taking marine mammals, a citizen of the United States who engages in a specific activity (other than commercial fishing) within a specified geographic region must obtain an incidental take authorization (ITA) under the MMPA. An ITA shall be granted if NMFS finds that the taking of small numbers of marine mammals of a species or stock by such

citizen with have a negligible impact on the affected species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses. The NMFS may also prescribe, where applicable, the permissible methods of taking and other means of effecting the least practicable impact on the species or stock and its habitat (i.e., mitigation, monitoring and reporting of such takings). An ITA may be issued as either (1) Letters of Authorization (LOA's) or (2) Incidental Harassment Authorizations (IHA's), that latter applicable when there is no potential for serious injury and/or mortality or where any such potential can be negated through required mitigation measures. Application instructions for marine mammal incidental take authorizations, whether an LOA or an IHA, can be found at the following URL: <http://www.nmfs.noaa.gov/pr/permits/incidental/htm>. The ITA applications currently under public review (including Arctic activities) can also be found at this site.

In order to issue an incidental take authorization, NMFS must find that the takings would be small in number, have no more than a "negligible impact" on marine mammal species or stocks, and not have an "unmitigable adverse impact" on subsistence uses of these species. Through these authorizations, NMFS must also identify:

- Permissible methods of taking pursuant to the activity and the specified geographical region of taking;
- The means of effecting the least practicable adverse impact on the species or stock and its habitat and on the availability of the species or stock for "subsistence" uses; and
- Requirements for monitoring and reporting, including requirements for the independent peer-review of proposed monitoring plans where the proposed activity may affect the availability of a species or stock for taking for subsistence uses.

Because of the likelihood that the oil and gas industry will be applying under this section of the MMPA for authorizations for activities related to proposed Chukchi Sea Sale 193 and because NMFS also has responsibilities under NEPA for these activities, NMFS has agreed at MMS's invitation, to become a cooperating agency in the preparation of this EIS.

I.C.4. The Magnuson Fishery Conservation and Management Act of 1976.

The Magnuson Fishery Conservation and Management Act of 1976 (16 U.S.C. 1801-1882) (MFCMA) established and delineated an area from the State's seaward boundary out 200 nautical miles as a fisheries conservation zone for the United States and its possessions. The Act created eight Regional Fishery Management Councils (FMC's) and mandated a continuing planning program for marine fisheries management by the Councils. The Act, as amended, requires that a Fishery Management Plan (FMP) based on the best available scientific and economic data be prepared for each commercial species (or related group of species) of fish that is in need of conservation and management within each respective region.

The MFCMA requires that FMC's identify essential fisheries habitat for every FMP that they develop, and they must go back and amend all existing plans to include the identification of this habitat. Essential fisheries habitat is defined as water and substrate for fish spawning, breeding, feeding, and growth to maturity. In Alaska, the NMFS and the North Pacific Fisheries Management Council (NPFMC) recently completed the final *Environmental Impact Statement for Essential Fish Habitat (EFH) Identification and Conservation in Alaska* (NMFS, 2005).

I.C.5. The Endangered Species Act.

The Endangered Species Act (ESA) of 1973, as amended, establishes protection and conservation of threatened and endangered species and the ecosystem on which they depend. The ESA is administered by the Fish and Wildlife Service (FWS) and NMFS. Section 7 of the Act governs interagency cooperation and consultation. The MMS consults with NMFS and FWS to ensure that activities on the OCS under MMS jurisdiction do not jeopardize the continued existence of a threatened or endangered species and/or result in adverse modification or destruction of their critical habitat. The FWS and NMFS make recommendations on the modifications of oil and gas operations to minimize adverse impacts, although it remains the responsibility of MMS to ensure that measures designed to protect threatened and endangered species are followed.

I.C.6. The Oil Pollution Act.

The Oil Pollution Act (OPA) of 1990 establishes a single uniform Federal system of liability and compensation for damages caused by oil spills in U.S. navigable waters. The OPA requires removal of spilled oil and establishes a national system for planning for and responding to oil-spill incidents. The OPA includes provisions to: (1) improve oil-spill prevention, preparedness, and response capability; (2) establish limitations on liability for damages resulting from oil pollution; (3) provide funding for natural resource damage assessment; (4) implement a fund for the payment of compensation for such damages; and (5) establish an oil pollution research and development program. The Secretary of the Interior is given authority over offshore facilities and associated pipelines (except deepwater ports) for all Federal and State waters. These functions include spill prevention, Oil-Spill-Response Plans (OSRP's), oil-spill-containment and -cleanup equipment, financial responsibility certification, and civil penalties.

I.C.7. The Clean Water Act.

The Federal Water Pollution Control Act (FWPCA) of 1972, as amended, commonly called the Clean Water Act (CWA), authorizes the U.S. Environmental Protection Agency (USEPA) to issue National Pollutant Discharge Elimination System (NPDES) permits to regulate discharges into waters of the United States. On March 4, 1993, the USEPA issued revised Effluent Limitations Guidelines and New Source Performance Standards that set more restrictive conditions than were previously applied to OCS discharges.

These limitations have been incorporated into the current USEPA Region 10 Alaska NPDES General permit for oil and gas exploratory facilities in offshore Alaska areas located in or adjacent to the Beaufort Sea, Chukchi Sea, Hope, and Norton Planning Areas (Permit No. AKG280000). The USEPA has the authority to regulate industrial and municipal discharges of pollutants to surface waters in the Pacific Northwest and Alaska under the NPDES. Offshore wastes from exploration activities may be discharged overboard in accordance with the NPDES General Permit. Development and production activities will require an individual NPDES permit issued to the operator by the USEPA Region 10, which will specifically identify discharge allowances and required operational practices for each facility covered under an individual permit.

I.C.8. The Clean Air Act.

The Clean Air Act (CAA), as amended, provides the legal authority for the USEPA's air pollution control programs. The law designates jurisdiction of OCS air quality to the USEPA within the Alaska region. Under the CAA, the Secretary is tasked to consult with the Administrator of USEPA "to assure coordination of air pollution control regulation for OCS emissions and emissions in adjacent onshore areas."

The USEPA regulations require certain facilities that emit criteria pollutants or hazardous substances into the air to get a permit before the facility is constructed or goes through significant modifications. Air quality permits are legally binding documents that include enforceable conditions with which the source owner/operator must comply. Some permit conditions are general to all types of emission units, and some permit conditions are specific to the source. Overall, the permit conditions establish limits on the types and amounts of air pollution allowed, operating requirements for pollution-control devices or pollution-prevention activities, and monitoring and record-keeping requirements. There are two types of permits: construction permits and operating permits. Construction permits are required for all new stationary sources and all existing stationary sources that are adding new emissions units or modifying existing emissions units.

The CAA places most of the responsibility on States to prevent and control air pollution within State boundaries, which include State waters. For a State to operate a USEPA-approved air quality program, the State must adopt a State Implementation Plan (SIP) and obtain approval of the plan from the USEPA. Federal approval ensures that a State program complies with the requirements of the CAA and USEPA rules. A SIP adopted by the State government and approved by the USEPA is legally binding under both State and Federal law and may be enforced by either government.

State law in Title 44, Chapter 46, Title 46, Chapter 3 and Chapter 14 establish the duties of the Division of Air Quality for controlling and mitigating air pollution. The provisions of Alaska's Prevention of Significant Deterioration (PSD) program are applied to attainment areas and unclassified Air Quality Control Regions (AQCR's) with good air quality to limit its degradation from development activities. The region of Alaska adjacent to the Chukchi and Beaufort seas is a PSD Class II area. The nearest PSD Class I areas are the Bering Sea Wilderness Area within the St. Matthew Island group and the Denali National Park. There are no Class III areas in Alaska. States strive to allow industrial and commercial growth within PSD Class II areas with permit conditions and requirements to mitigate significant degradation of existing air quality or exceeding the National Ambient Air Quality Standards.

I.C.9. The Resource Conservation and Recovery Act.

The Resource Conservation and Recovery Act (RCRA) establishes a system to manage wastes. Subtitle D of the RCRA addresses nonhazardous solid wastes, such as wood, paper, and scrap metal. It includes certain hazardous wastes that are exempted from the Subtitle C regulations, such as hazardous wastes from households and most wastes generated from conditionally exempt small-quantity generators. Subtitle D wastes are managed primarily at the State or local level. Congress intended via RCRA Subtitle D that permitting and monitoring of municipal and nonhazardous waste landfills shall be a State responsibility.

Under the RCRA hazardous-waste regulations, Subtitle C, the USEPA has primary responsibility for the permitting of hazardous-waste treatment, storage, and disposal facilities.

Subtitle C of the RCRA establishes a Federal program to manage hazardous wastes from "cradle to grave" to ensure that hazardous waste is handled in a manner that protects human health and the environment. Therefore, the USEPA has established regulations and procedures for the generation, transportation, storage, and disposal of hazardous waste. Regulated waste handlers apply for a hazardous-waste RCRA identification number by registering their activities and reporting their volumes, either annually or biennially, to the regional USEPA, RCRA program office.

I.C.10. The Marine Plastic Pollution Research and Control Act.

The Marine Plastic Pollution Research and Control Act of 1987 implements Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL). Alaska has received "Special Area" status under MARPOL, thereby prohibiting the disposal of all solid waste into the marine environment. Fixed and floating platforms, drilling rigs, manned production platforms, and support vessels operating under a Federal oil and gas lease are required to develop Waste Management Plans and to post placards reflecting discharge limitations and restrictions.

I.C.11. The Coastal Zone Management Act.

Pursuant to the Coastal Zone Management Act (CZMA) and the Coastal Zone Reauthorization Amendments of 1990, all Federal activities, including OCS oil and gas lease sales and postlease activities, must be consistent to the maximum extent practicable with the enforceable policies of each affected State's coastal zone management program (CZMP). Each State's CZMP sets forth objectives, policies, and standards relative to public and private use of land and water resources in the coastal zone.

The Alaska Legislature enacted the Alaska Coastal Management Act on June 4, 1977, (Ch. 84 LSA 1977), which established the Alaska Coastal Management Program (ACMP). Alaska's program is voluntary at the local level; however, the ACMP process encourages local land use planning that, coupled with Statewide policies, provide coordinated, intergovernmental evaluation of a proposed coastal project. The process involves a partnership between the State project review team, the applicant, the coastal districts, State/Federal agencies, and the public. The ACMP thus places emphasis on coordination between State, local, national, and private interests in the management and use of coastal resources.

The OCS seaward of the State's 3-mi limit in Federal waters is a "geographic location description" for purposes of Federal consistency reviews under 15 CFR 930.34(b) and 930.53(a). A Federal activity on the OCS that causes effects on any Alaskan coastal use or resource, as the term "effects" is defined in the

CZMA at 15 CFR 930.11(g), must be consistent with ACMP. The State of Alaska reviews OCS Exploration Plans (EP's) and Development and Production Plans (DPP's) to determine whether the proposed activities are consistent with the State's CZM plan. The MMS may not issue a permit for activities described in a plan unless the State concurs.

The MMS Alaska OCS Region sends copies of an EP and DPP, including a consistency certification and other necessary information, to the Governor of the State of Alaska who sends it to the State of Alaska, Department of Natural Resources (ADNR), Office of Project Management and Permitting. If no State-agency objection is submitted by the end of the review period, MMS shall presume consistency concurrence by the State. If a written consistency concurrence is received from the State, MMS' Alaska OCS Region may then approve any permit or plan. If the Alaska Region receives a written objection from the State, the Region will not approve any permit for that activity, until consistency of the activity is achieved. The Alaska Region does not impose or enforce additional State conditions when issuing permits but can require modification of a plan, if the operator has agreed to requirements requested by the State.

The State of Alaska also amended its coastal management program in late 2004. The U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of Ocean and Coastal Resource Management, completed its review and approved the amended ACMP on December 29, 2005. The new Statewide standards are found under Title 11, Alaska Administrative Code, Chapters 110, 112, and 114; the new standards apply to all consistency reviews conducted after January 4, 2006. Under the amended ACMP, all coastal districts must revise their local plans to conform to the new Statewide standards. A district's existing coastal management program, however, will remain in effect until September 1, 2007, unless the ADNR disapproves or modifies all or part of the program before that date. Also, any existing district-enforceable policy that duplicates, restates, or incorporates by reference a statute or regulation of a Federal or State agency or addresses any matter regulated by the Alaska Department of Environmental Conservation are repealed and declared null and void under the amended ACMP.

I.C.12. Executive Order 12898: Environmental Justice.

The Environmental Justice policy, based on Executive Order 12898, requires agencies to incorporate analysis into NEPA documents of the environmental effects of their proposed programs on minorities and low-income populations and communities. The MMS' existing presale planning process invites participation in the development of its proposed actions, alternatives, and possible mitigation measures by all groups and communities. Scoping and review for the EIS are open processes that provide an opportunity for all participants, including minority and low-income populations, to raise concerns that can be addressed in the EIS.

I.C.13. Executive Order 13112: Aquatic Invasive Species.

Executive Order 13112 was issued in 1999 with the intent "to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause." "Invasive species" means an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health. "Alien species" means, with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem. Each Federal Agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law:

- (1) identify such actions;
- (2) subject to the availability of appropriations, and within Administration budgetary limits, use relevant programs and authorities to: (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and (vi) promote public education on invasive species and the means to address them; and

(3) not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

The Coast Guard has established both regulations and voluntary guidelines to control the invasion of aquatic nuisance species (ANS). Ballast water from ships is one of the largest pathways for the intercontinental introduction and spread of ANS. This rule finalizes regulations for the Great Lakes ecosystem and voluntary ballast water management guidelines for all other waters of the United States, including mandatory reporting for nearly all vessels entering waters of the United States. This final rule is effective December 21, 2001.

I.C.14. Executive Order 13212: Actions to Expedite Energy-Related Projects.

Executive Order 13212 states that "...in order to take additional steps to expedite the increased supply and availability of energy to our Nation..." it is necessary to improve the Federal Government's internal management of actions associated with energy-related projects. In general, the executive order directs executive departments and agencies to take appropriate actions to expedite projects that will increase the production, transmission, or conservation of energy. Departments and agencies must expedite their review of permits or take other actions as necessary to accelerate the completion of such projects while maintaining safety, public health, and environmental protections. Agencies must take such actions to the extent permitted by laws and regulations where appropriate.

I.C.15. Executive Order 13175: Consultation and Coordination with Indian Tribal Governments.

The United States recognizes the right of the Indian tribes to self-government and supports tribal sovereignty and self-determination. Executive Order 13175 establishes regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications. The United States has a unique legal relationship with Indian tribal governments and regional and tribal corporations as set forth in the Constitution of the United States, treaties, statutes, executive orders, and court decisions. Executive Order 13175 supplements but does not supersede the requirements contained in Executive Orders 12866 (Regulatory Planning and Review) and 12988 (Civil Justice Reform), Office of Management and Budget Circular A-19, and the Executive Memorandum of April 29, 1994, on Government-to-Government Relations with Native American Tribal Governments. The United States continues to work with Indian tribes on a government-to-government basis to address issues concerning Indian tribal self-government tribal trust resources, and Indian tribal treaty and other rights.

The MMS incorporates a government-to-government consultation process within all prelease and postlease regulatory policy decisions that have tribal implications, to ensure meaningful and timely input by tribal officials. This process includes early consultation with tribal officials. The MMS conducts a government-to-government dialog with Native groups, both in formal agency meetings and in the open public forum throughout the pre-lease and NEPA processes. Additional information on government-to-government coordination is provided in Section VI.D. Traditional Knowledge, Environmental Justice, Indian Trust Resources, and government-to-government coordination are addressed in this EIS.

I.C.16. MMS Regulations.

The MMS operating regulations are intended to ensure that OCS activities are carried out in a safe and environmentally sound manner so as to prevent harm or damage to, or waste of, any natural resources (including any mineral deposit in areas leased or not leased), any life (including fish and other aquatic life), property, or the marine, coastal, or human environment. Regulations for lease operations on the OCS are specified in 30 CFR 250. These regulations govern oil, gas, and sulphur exploration, development, and production activities. Ancillary activities on a lease to support preparation of EPs and DPP's are conducted under 30 CFR 250. Regulations for geological and geophysical (G&G) exploration activities on the OCS

are specified in 30 CFR 251. Under these regulations, a G&G permit must be obtained for exploration activities on unleased lands or in lands under lease to a third party. Regulations related to oil-spill prevention and response are specified in 30 CFR 254. Additional discussion of the requirements for OCS operations is provided below in Section I.E.

I.C.17. Other Applicable Laws and Regulations.

The following is a list of other applicable laws and regulations that apply to MMS OCS activities. A brief description of these laws and regulations is provided in Appendix D of the Beaufort Sea Multiple Sale EIS (USDOJ, MMS, 2003a).

- Submerged Lands Act of 1953 (43 U.S.C. § 1331 et seq.)
- 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))
- Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. § 703-712)
- Pollution Research and Control Act of 1988 (33 U.S.C. § 1901 et seq.)
- National Historic Preservation Act of 1966, as amended (16 U.S.C. § 470 et seq.)
- Rivers and Harbors Appropriation Act of 1899 (33 U.S.C. § 401 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 13158 – Marine Protected Areas
- Executive Order 12114 – Environmental Effects Abroad

I.D. Prelease Process.

In 2002, the Secretary issued the Final OCS Oil and Gas Leasing Program for 2002-2007 (5-Year Program). That document presented the decision to consider annual “special-interest” sales in the Chukchi Sea /Hope Basin OCS Planning Areas. The objective of this “special-interest” leasing option was to foster exploration in a frontier OCS area with potential oil and gas resources but may have minimal industry interest because of high operating costs. The general approach for special interest leasing was to query industry regarding the level of interest for proceeding with a sale in an area such as the Chukchi Sea/ Hope Basin. We expected nominations of focused areas of specific industry interest or to offer such areas for lease. Based on the information and specific nominations received as a result of each Call for Interest and Nominations (Calls), a decision was made whether to proceed with the sale process.

We received no indication of interest in response to the first two Calls for special interest leasing in the Chukchi Sea/ Hope Basin published in the *Federal Register* on March 25, 2003 (68 *FR* 14425), and January 30, 2004 (69 *FR* 4532); therefore, the process was stopped.

In response to the third Call published in the *Federal Register* on February 9, 2005 (70 *FR* 6903), industry nominated a substantial portion of the Planning Area. This area was greater than that envisioned in the special-interest lease-sale option described above. The MMS concluded that consideration of such a large area had merit in light of the significant resource potential of the area and the Administration’s goal to expedite exploration of domestic energy resources. The MMS further concluded that consideration of such a proposed action warranted a more extensive NEPA review than contemplated under the special interest leasing option.

With the publication of a Notice of Intent to Prepare an Environmental Impact Statement in the *Federal Register* on September 14, 2005 (70 *FR* 54406), MMS initiated the process to prepare a comprehensive “areawide” EIS for proposed Sale 193. The prelease process was not completed in time to allow the Sale during the 2002-2007, 5-Year Program, which expired on June 30, 2007. As a result of timing, the proposed Sale 193 is recognized as occurring during the 2007-2012, 5-year program for administrative purposes but remains consistent with the original assumptions from the previous program. Proposed Sale

193 is scheduled for February 2008, subject to its final adoption of the 2007-2012 Program by the Secretary of the Interior.

Based on available information, MMS formally identified the location and extent of the area of study for the EIS, four alternatives, and mitigation measures. The area includes 6,156 whole or partial blocks (about 34 million acres). The program area as defined in the 2002-2007 5-Year Program excludes a corridor along the coast up to approximately 50 miles, the polynya or Spring Lead System.

Consistent with Section 102(2)(C) of NEPA, this EIS describes the proposed lease sale and the potentially affected natural and human environments, presents an analysis of potential adverse effects of the Proposed Action on these environments, evaluates mitigating measures to reduce the potential for adverse effects of offshore leasing and development, evaluates alternatives to the proposed Federal actions, analyzes prelease seismic-survey activity, and presents a record of consultation and coordination with others during EIS preparation. The EIS will be filed with the USEPA on completion, and its availability will be announced in the *Federal Register*. The public will have 30 days to review and comment on the final EIS. After receipt and consideration of comments on the final EIS, MMS will publish a Record of Decision.

By regulation and law, MMS is required to review and analyze the environmental effects of this lease sale as well as prelease seismic-survey activity. Through the scoping process, we asked for comments and concerns about this proposed lease sale and associated activities. 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 the draft EIS, both written and oral, in Section VII. This includes letters, public hearings, government-to-government meetings, and e-mails .

The MMS has identified the agency-preferred alternative to be Alternative IV, including the standard stipulations and Information to Lessees (ITL) clauses, plus a revision to Stipulation No. 7 and a new ITL, No. 15 - Possible listing of Polar Bears under the ESA. Although we have identified an agency-preferred alternative, as required by NEPA CEQ 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.E. Postlease Processes.

The MMS is responsible for regulating and monitoring the oil and gas operations on the Federal OCS. Regulations provide for MMS to regulate all operations conducted under the lease, right of use and easement, or USDOJ pipeline right-of-way; to promote orderly exploration, development, and production of mineral resources; and to prevent harm or damage to, or waste of, any natural resource, any life or property, or the marine, coastal, or human environment. Regulations for oil, gas, and sulphur lease operations on the OCS are specified in 30 CFR 250. Regulations for G&G exploration operations on the OCS are specified in 30 CFR 251. Regulations related to oil-spill prevention and response are specified in 30 CFR 254.

The MMS' Notices to Lessees and Operators (NTL's) are formal documents that provide clarification, description, or interpretation of OCS regulations or standards. The NTL's provide guidelines on the implementation of lease stipulations or regional requirement, and provide industry with a better understanding of the scope and meaning of regulations by explaining MMS' interpretation of a requirement. The NTL's also are used to transmit administrative information such as current telephone listings or changes in MMS personnel. A detailed listing of the Alaska OCS Region's NTL's is published on the Alaska Region web page at: <http://www.mms.gov/alaska/regs/NTL's.htm>. The MMS also conveys important information by way of Letters to Lessees and Operators and Information to Lessees and Operators. These documents further clarify or supplement operational guidelines.

I.E.1. Geological and Geophysical Exploration Permits.

In accordance with 30 CFR 251, a permit must be obtained from MMS prior to conducting geological or geophysical exploration for mineral resources, except exploration by a lessee on a lease. Upon receiving a complete G&G permit application, MMS completes an environmental review in accordance with NEPA and other applicable MMS policies and guidelines. When required under an approved CZMP, proposed G&G permit activities must receive State concurrence prior to MMS permit approval and issuance.

I.E.2. Exploration Plans, and Development and Production Plans.

Prior to any exploration, development, or production activities being conducted in a lease block (other than preliminary on-lease activities, such as geotechnical investigations), an EP or DPP, as appropriate, and supporting information must be submitted to MMS for review and approval. Supporting information includes environmental information, archeological report, biological report in accordance with 30 CFR 250 (monitoring and/or live-bottom survey), or other environmental data determined necessary. This information provides an analysis of both offshore and onshore impacts that may occur as a result of the activities. The MMS prepares an EA and/or EIS based on available information, which may include the geophysical report, archeological report, and air-emissions data. As part of the review process, the plan and supporting environmental information, as required, are sent to the affected State(s) having an approved CZM plan for consistency-certification review and determination. The MMS evaluates the proposed activity for geohazards and manmade hazards, archeological resources, endangered species, sensitive biological features, water and air quality, oil-spill response, and other uses of the OCS.

I.E.3. Archaeological Resources Protection.

The Archaeological Resource requirements are contained in the MMS operational regulations under CFR 250.194. The technical requirements for the archaeological resource surveys and reports that may be required under the regulations are detailed in the Alaska OCS Region NTL 05-A02 and NTL 05-A03.

I.E.4. Applications for Permits to Drill.

Prior to conducting drilling operations, the operator is required to submit and obtain approval for an Application for Permit to Drill (APD). The APD requires detailed information on the seafloor and shallow seafloor conditions for the drill site from shallow geophysical and, if necessary, archeological and biological surveys. The lessee is required to take precautions to keep all exploratory well drilling under control at all times. The APD requires detailed information about the drilling program to allow evaluation of operational safety and pollution-prevention measures. The lessee must use the best available and safest technology to enhance the evaluation of abnormal pressure conditions and to minimize the potential for uncontrolled well flow.

I.E.5. Best Available and Safest Technology Requirements.

To ensure that all oil and gas exploration, development, and production activities on the OCS are conducted in a safe and pollution-free manner, the OCS Lands Act requires that all OCS technologies and operations use the best available and safest technology that the Secretary determines to be economically feasible. These include requirements for state-of-the-art drilling technology, production-safety systems, well control, completion of oil and gas wells, OSRP's, pollution-control equipment, and specifications for platform/structure designs.

I.E.6. MMS Technical and Safety Review.

The lessee must design, fabricate, install, use, inspect, and maintain all platforms and structures on the OCS to ensure their structural integrity for the safe conduct of operations at specific locations. Applications for platform design and installation are filed with MMS for review and approval.

Production-safety equipment used on the OCS must be designed, installed, used, maintained, and tested in a manner to ensure the safety and protection of the human, marine, and coastal environments. All tubing

installations open to hydrocarbon-bearing zones below the surface must be equipped with safety devices that will shut off the flow from the well in the event of an emergency, unless the well is incapable of flowing. All surface production facilities must be designed, installed, and maintained in a manner that provides for efficiency, safety of operations, and protection of the environment.

I.E.7. Pipeline Regulations.

Regulatory processes and jurisdictional authority concerning pipelines on the OCS and in coastal areas are shared by several Federal Agencies, including the USDOJ, the U.S. Department of Transportation, the U.S. Army Corps of Engineers, the Federal Energy Regulatory Commission, and the U.S. Coast Guard.

Pipeline-permit applications to MMS include the pipeline location drawing, profile drawing, safety schematic drawing, pipe-design data to scale, a shallow-hazard-survey report, and an archaeological report. The MMS evaluates the design and fabrication of the pipeline and prepares a Categorical Exclusion Review (CER), Environmental Assessment (EA), and/or an EIS in accordance with applicable policies and guidelines. The MMS prepares an EA and/or an EIS on all pipeline rights-of-way that go ashore. The FWS reviews and provides comments on applications for pipelines that are near certain sensitive biological communities. No pipeline route will be approved by MMS if any bottom-disturbing activities (from the pipeline itself or from the anchors of lay barges and support vessels) encroach on any biologically sensitive areas. The operators are required to periodically inspect their routes by methods prescribed by the MMS Regional Supervisor for any indication of pipeline leakage. Some examples of pipeline monitoring techniques include visual monitoring, comparing the volume of product entering and exiting the pipeline, inline inspection tools (smart pigs), external hydrocarbon-vapor detection (leak-detection system), and pressure analysis. Monthly overflights are conducted to inspect pipeline routes for leakage.

Pipelines may be abandoned in place, if they do not constitute a hazard to navigation and commercial fishing or unduly interfere with other uses of the OCS. Procedures for pipeline abandonment and pipeline reporting requirements are outlined at 30 CFR 250.156 and 250.158.

I.E.8. Oil-Spill-Response Plans.

In compliance with 30 CFR 254, all owners and operators of oil-handling, -storage, or -transportation facilities located seaward of the coastline must submit an OSRP to MMS for approval. Owners or operators of offshore pipelines are required to submit a plan for any pipeline that carries oil, condensate that has been injected into the pipeline, or gas and naturally occurring condensate; pipelines carrying essentially dry gas do not require a plan. A response plan must be submitted before an owner/operator can use a facility. To continue operations, the facility must be operated in compliance with the approved plan.

All MMS-approved OSRP's are required to be reviewed and updated every 2 years. Revisions to a response plan must be submitted to MMS within 15 days whenever (1) a change occurs that significantly reduces an owner/operator's response capabilities; (2) a significant change occurs in the worst-case-discharge scenario or in the type of oil being handled, stored, or transported at the facility; (3) there is a change in the name(s) or capabilities of the oil-spill-removal organizations cited in the plan; or (4) there is a significant change in the appropriate Area Contingency Plans.

I.E.9. Discharge and Pollution Regulations.

The USEPA has promulgated regulations (40 CFR 125) to ensure lessees do not create conditions that will pose an unreasonable risk to public health, life, property, aquatic life, wildlife, recreation, navigation, commercial fishing, or other uses of the ocean. Control and removal of pollution is the responsibility and at the expense of the lessee. Operators are required to install curbs, gutters, drip pans, and drains on platform and rig deck areas in a manner necessary to collect all contaminants and debris not authorized for discharge. The rules also explicitly prohibit the disposal of equipment, cables, chains, containers, or other materials into offshore waters. Portable equipment, spools or reels, drums, pallets, and other loose items weighing 18 kilograms or more must be marked in a durable manner with the owner's name prior to use or transport over offshore waters. Smaller objects must be stored in a marked container when not in use.

Operational discharges such as produced water and drilling muds and cuttings are regulated by the USEPA through the NPDES program.

I.E.10. Structure Removal and Site Clearance.

Lessees/operators have one year from the time a lease is terminated to remove all wells and structures from a lease (30CFR Subpart Q). Prior to conducting these operations the operator must provide information that includes but is not limited to the following (30 CFR 250.1727) :

- complete identification of the structure; size of the structure (number and size of legs and pilings);
- removal technique to be employed (if explosives are to be used, the amount and type of explosive per charge); and
- the number and size of well conductors to be removed and the removal technique.

The MMS requires lessees to submit a procedural plan for site-clearance verification. Lessees must ensure all objects related to their activities were removed following termination of their lease.

I.E.11. MMS Inspection Program.

The MMS inspection program in Alaska is directed by the OCS Regional Office in Anchorage, Alaska, which provides review and inspection of oil and gas operations. The MMS conducts onsite inspections to ensure compliance with lease terms, NTL's, and approved plans, and to ensure that safety and pollution-prevention requirements of regulations are met. These inspections involve items of safety and environmental concern. Further information on the baseline for the inspection of lessee operations and facilities can be found in the *National Potential Incident of Noncompliance List* (USDOJ, MMS, 2005c). If an operator is found in violation of a safety or environmental requirement, a citation is issued. Depending on the nature of the violation, actions can range from requiring that the violation be fixed within 14 days (for minor violations) to immediate suspension of production or other operations (for violations that pose a threat of serious or immediate harm or damage to the marine, coastal or human environment).

The primary objective of initial inspections is to ensure proper installation of mobile units or structures and associated equipment. After operations begin, additional announced and unannounced inspections are conducted. Unannounced inspections are conducted to foster a climate of safe operations, to maintain an MMS presence, and to focus on operators with a poor performance record. They also are conducted after a critical safety feature previously had been found defective. Annual inspections are conducted on all platforms, but more frequent inspections may be conducted on rigs and platforms. Onboard inspections involve the inspection of all safety systems of a production platform.

I.E.12. Training Requirements for Offshore Personnel.

An important factor in ensuring that offshore oil and gas operations are carried out in a manner that emphasizes operational safety and minimizes the risk of environmental damage is the proper training of personnel. All operators must have trained personnel to operate oil-spill-cleanup equipment or must have retained a trained contractor(s) that will operate the equipment for them. Offshore personnel also are required to have well control and production safety training (30 CFR 250.1500).

I.F. 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 for the lease-sale action in the document; no new additions or deletions were included for the Lease Sale 193 analyses. However, as a result of the Secretary of the Interior making a decision to include a 25-mi buffer zone in the 2007-2012 5-Year Program, Alternative I has 129 whole or partial blocks removed and Alternatives III and IV (Corridors I and II) have 6 whole or partial blocks removed from consideration from leasing.

- Alternative B was added for the exploration seismic-survey process analyzed in the document. Alternative B would prohibit presale-193 seismic surveys in the Corridor II Deferral Area (Alternative IV).
- Alternative IV is identified as the Agency-Preferred Alternative and is addressed in Section II.B.I.
- Stipulation No. 7 - Lighting of Lease Structures to Minimize Effects to spectacled and Steller's Eiders was rewritten in consultation with FWS to better address the potential impacts associated with spectacled and Steller's eider and habitat.
- Information to Lessee No. 15 - Polar Bears being listed as a candidate species for the threatened and endangered list by FWS.
- Information to Lessees No.'s 16 - 24 - have been included in the final EIS, even though they are not new to the lease-sale process and are considered administrative in nature.
- Text revisions focused on major issues dealing with seismic, marine mammals, subsistence, the bowhead whale, polar bears, Spectacled eiders, oil spills, 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. Section VII includes the comment letters received plus our responses to comments.

SECTION II

**ALTERNATIVES
INCLUDING
THE PROPOSED ACTION**

Contents for Section II

II. ALTERNATIVES INCLUDING THE PROPOSED ACTION II-1

II.A. Lease Sale 193 National Environmental Policy Act Analysis II-1

II.B. Alternatives, Mitigation Measures, and Issues II-1

- II.B.1. Alternatives for Proposed Sale 193 and the Exploration Seismic-Survey Activities II-3
- II.B.2. Alternatives Considered but Not Analyzed II-3
- II.B.3. Mitigation Measures Specific to the Lease-Sale Process for Sale 193 II-5
- II.B.4. Mitigation Measures for Seismic Operations in the Chukchi Sea II-24
- II.B.5. Issues II-29

II.C. Proposed Chukchi Sea Lease Sale II-32

- II.C.1. Alternative I – Proposed Action II-32
- II.C.2. Alternative II – No Lease Sale II-40
- II.C.3. Alternative III – Corridor I Deferral II-40
- II.C.4. Alternative IV – Corridor II Deferral (Agency-Preferred Alternative) II-43

II. ALTERNATIVES INCLUDING THE PROPOSED ACTION

II.A. Lease Sale 193 National Environmental Policy Act Analysis.

Readers of this Sale 193 final environmental impact statement (EIS) are alerted to some noticeable differences in this EIS as compared to previous Alaska Outer Continental Shelf (OCS) EIS's. To provide a more concise, reader-friendly, and useful analysis of potential effects and impacts of proposed activities, Minerals Management Service (MMS) has begun to streamline its EIS's. For example, the previous Chukchi Sea Lease Sale 126 analysis of environmental effects presented three separate resource levels (low, base, and high); the Sale 193 analysis treats a composite of this information in a single-case analysis. This single case represents the statistically most-likely development activity associated with a reasonable range of resources estimated for the Sale 193 area given the uncertainties of geology, engineering, and economics that exist now. Furthermore, the Sale 193 EIS also analyzes prelease and postlease exploration seismic-survey activity in the Chukchi Sea Planning Area and complements the Programmatic Environmental Assessment (PEA) *Arctic Ocean Outer Continental Shelf Seismic Surveys – 2006* (USDOI, MMS, 2006a). The Sale 193 EIS summarizes and incorporates relevant background information from the PEA for seismic activities in the Chukchi Sea, which is incorporated by reference. Such streamlining and use of incorporation by reference follows the intent of the Council on Environmental Quality (CEQ) regulations of 40 CFR 1502.21, which encourage agencies to incorporate by reference material into an EIS. The MMS cites the incorporated material and briefly describes and summarizes its content. All material incorporated by reference is reasonably available for inspection by interested persons and is available either in local public libraries or from the MMS Alaska OCS Region website.

The Secretary's Final Proposed OCS Leasing Program for 2007-2012 includes an alternative for a 25 Statute Mile Buffer Deferral in the Chukchi Sea Planning Area (USDOI, MMS, 2006c:Fig. 2-1). An analysis for the 25-mile buffer deferral can be found in the 2007-2012 5-Year Program EIS. A decision was made by the Secretary of Interior (during the Sale 193 NEPA process) to adopt the 25-mile deferral in the Final Proposed 2007-2012 5-Year Program. The result of this decision is to exclude from Sale 193 a total of 129 whole or partial blocks representing approximately 534,668 acres from the sale area (Figure II.B-2). Alternatives III and IV are also slightly altered with the removal of six whole or partial blocks representing approximately 34,159 acres (Figure II.B-3). The implementation of the 25-mile buffer by the Secretary does not change the existing impact analyses for the lease sale alternatives.

II.B. Alternatives, Mitigation Measures, and Issues.

With the publication of a Notice of Intent (NOI) to Prepare an Environmental Impact Statement in the *Federal Register* on September 14, 2005 (70 FR 54406), MMS initiated the process to prepare a comprehensive "areawide" EIS for proposed Lease Sale 193. The prelease process will not be completed in time to allow the Sale during the 2002-2007 5-Year Program, which expires on June 30, 2007. Lease Sale 193 is tentatively scheduled for February 2008, subject to its final adoption of the 2007-2012 Program by the Secretary of Interior.

In accordance with the CEQ's procedures for implementing the procedural provisions of NEPA, scoping was conducted to solicit comments on the Proposed Action and the Lease Sale EIS. Scoping provides those with an interest in the OCS Program an early opportunity to participate in the events leading to the publication of the draft EIS. Although the scoping process is formally initiated by the publication of the Call for Information (Call) and NOI, scoping efforts and other coordination meetings are ongoing. Further information on the scoping process is found in Section VI. The Call for Information initiates the process to solicit industry in order to establish interest in a proposed lease sale.

The MMS also conducted coordination with appropriate Federal and State agencies and other MMS Alaska OCS Region stakeholders to discuss the proposed lease sale. Key agencies and organizations included the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS),

Fish and Wildlife Service (FWS), Environmental Protection Agency (USEPA), State Governor's office, tribes and local governments, and industry groups.

The result of the scoping effort was the identification of the alternatives, mitigation measures, and issues described in the following.

The Chukchi Sea Planning Area experienced a modest level of activity in the late 1980's and early 1990's and renewed interest as an area of potential oil and gas leasing in the last few years. The current Chukchi Sea Planning Area includes a 1,952-block area north of Barrow that was part of the Beaufort Sea Planning Area prior to 1991. Portions of the current area were offered in four previous lease sales (Beaufort Sea Sale 97 and Chukchi Sea Sale 109 in 1988 and Beaufort Sea Sale 124 and Chukchi Sea Sale 126 in 1991).

A Call and NOI were issued at the beginning of the prelease process to explain the lease-sale approach for the EIS. The Area Identification (Area ID) selected the same area identified in the 5-Year Program for 2002-2007. If following the completion of the NEPA process, the decision is made to proceed with the sale, a Notice of Sale will be issued.

This EIS includes an assessment of alternatives and cumulative effects. The cumulative-effects analysis evaluates the contribution of Alternative I (Proposed Action) for Sale 193 to the past, present, and reasonably foreseeable activities, including State and Federal onshore and offshore activities in the Chukchi Sea area. The cumulative effects of Alternatives III and IV for Sale 193 are expected to be essentially the same as those for Alternative I for Sale 193, because the potential effect of each of these alternatives is based on the same oil- and gas-resource estimate and scenario of projected activities. Anticipated production and associated activities are analyzed based on economic resource estimates established at the beginning of the 5-Year Program. This EIS analyzes the effects of exploration, development, and production quantitatively to the degree possible, using the economic and development scenario established for Sale 193. Impacts that cannot be estimated quantitatively are described qualitatively. The scenario covers the resources and activities that are likely to result from the Proposed Action (Alternative I). This EIS assumes that standard Alaska OCS Region mitigation measures are in place as part of the Proposed Action; the EIS will assess the effects of possible new mitigation measures added to existing standard mitigation measures.

Based on the results of the scoping process, alternatives are analyzed that defer certain blocks from the sale. Alternatives were identified and are evaluated by comparing changes in resource production and environmental effects relative to the entire program area. This final EIS identifies the agency-preferred alternative in Section I.A.

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 and 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.

If the Secretary of the Interior decides to proceed with the sale, the Secretary may choose one, all, some combination, or part of the deferral options to constitute the Final Notice of Sale for Sale 193. The Secretary will have the full suite of options available for Sale 193 when that decision is made.

Consideration of the Final EIS and any comments received during the prelease and NEPA processes will result in a Record of Decision (ROD) and will be incorporated into the Secretary's decision on the Sale, which will be published in the *Federal Register* as the Final Notice of Sale.

II.B.1. Alternatives for Proposed Sale 193 and the Exploration Seismic-Survey Activities.

II.B.1.a. Lease Sale Alternatives.

Alternative I (Proposed Action). The Proposed Action offers for lease those blocks selected in the Area ID, as shown in Map 1. The Chukchi Sea sale area includes 6,156 whole or partial blocks covering approximately 34 million acres in the Chukchi Sea.

Alternative II (No Lease Sale). This alternative is equivalent to cancellation of the Proposed Action. The opportunity for development of the estimated oil and gas resources that could have resulted from any of the Proposed Action would be precluded or postponed, and any potential environmental impacts resulting from the Proposed Action would not occur or would be postponed.

Alternative III (Corridor I Deferral). This alternative is the Proposed Action excluding an area comprising approximately 1,765 whole or partial blocks along the coastward edge of the sale area as identified in the Area ID (Map 2). This alternative would attempt to reduce potential impacts to subsistence hunting (see Fig. II-B.1, Volume III, Tables, Maps, and Figures) as well as various wildlife species and associated habitats.

Alternative IV (Corridor II Deferral) (Agency Preferred Alternative). This alternative is the Proposed Action excluding an area comprising approximately 795 whole or partial blocks along the coastward edge of the sale area as identified in the Area ID (Map 3). This alternative was developed as a result of the 1987 Biological Opinion for the Chukchi Sea as recommended by the NMFS.

II.B.1.b. Exploration Seismic Survey Activities Alternatives.

Alternative A (Exploration Seismic Surveys within the Entire Proposed Sale 193 Area).

The proposed action for seismic surveying is to permit both prelease and postlease exploration seismic surveys within the entire proposed Sale 193 area. All permitted seismic surveys would be subject to the standard stipulations for G&G permit activities (Sec. II.A.4), the measures to mitigate seismic-surveying effects (Sec. II.B.4.a), and the mitigation and monitoring requirements of the selected alternative (Alternative 6) from the *Final Programmatic Environmental Assessment (PEA), Arctic Ocean Outer Continental Shelf Seismic Surveys - 2006*, date June 2006 (USDOJ, MMS, 2006a) (Sec. II.B.4.b).

Alternative B (Prohibit Pre-Sale 193 Exploration Seismic Surveys in the Corridor II Deferral Area).

This alternative to the proposed action for seismic surveys (Alternative A) would prohibit pre-Sale 193 seismic surveys in the 795 whole or partial blocks in Corridor II Deferral area (Alternative IV) along the coastward edge of the proposed Sale 193 area until the lease sale decisions have been made and the NMFS/MMS Seismic Programmatic EIS has been completed.

II.B.2. Alternatives Considered But Not Analyzed.

The following alternatives were identified during the scoping process. For the reason indicated under each, they are not considered for detailed study in the EIS.

Public Land Order Deferral. A statement at one meeting in Barrow indicated the belief that Public Land Order 324 gave subsistence-hunting rights to Natives 50-mi out into the ocean and, that if still valid, the right-of-way should be applied. On further investigation, this Order appears to be related to the following statement found in Indian Affairs: *Laws and Treaties compiled by the Government Printing Office*. If so, the referenced reserved offshore area occurs within State waters and is outside of the proposed Chukchi Sea Sale 193 area.

Subject to valid existing rights and to existing withdrawals, the following described public lands in Alaska are hereby temporarily withdrawn from settlement, location, sale, or entry and reserved for the purpose of classification and proposed designation under section 2 of the act of May 1, 1936,

49 Stat. 1250 (U.S.C., Title 48, sec. 358a), as a native reservation for the use and occupancy of the native inhabitants of the native village of Barrow and vicinity, Alaska:

Beginning at a point on the Arctic Ocean 30 miles southwest of Point Barrow, air line, approximately latitude 71°05'27" N., approximately longitude 157°10'W., running thence in a southeasterly direction of McTavish Point; thence following along the coast of Dease Inlet, Elson Lagoon, and the Arctic Ocean, including Point Barrow, to the place of beginning, and including the waters adjacent to the above-described area extending 3,000 feet from the shore at mean low tide, all as shown on the Reconnaissance Map of Northwestern Alaska, 1930, prepared by the United States Geological Survey in cooperation with the Bureau of Engineering, Department of the Navy, containing approximately 750 square miles of land and approximately 50 square miles of water. (http://digital.library.okstate.edu/kappler/vol7/html_files/v7p1459b.html)

Chukchi Sea/Beaufort Sea Deferral. The North Slope Borough (NSB) suggested it is appropriate to defer from leasing the entire Chukchi Sea Planning Area and portions of the Beaufort Sea Planning Area. This alternative is appropriately addressed at the 5-Year Program level. For Sale 193, this deferral approximates the No Lease Sale alternative (Alternative II), which is discussed in the EIS.

Cancel the Sale. This alternative was most often suggested by those expressing a preference. At the Barrow public meeting, we received a suggestion to drill for oil and gas on land first and exhaust the availability of land-based oil and gas reserves prior to exploration, development, and production of offshore oil and gas reserves. This alternative to delay the sale is equivalent to the Alternative II (No Lease Sale) analyzed in this EIS.

Directional Drilling Alternative. A commenter in Barrow requested that only areas that could be directionally drilled from onshore be included in the lease sale. The Sale 193 area appears to be beyond the limit of reasonably foreseeable advances in technology for extended-reach drilling from shore. The MMS, Alaska OCS Region, Office of Field Operations provided information on the present horizontal distance achievable by extended-reach drilling, the distance envisioned by one operator to develop Liberty in the Beaufort Sea, and an anticipated 10-year maximum theoretical distance of 40,000 ft. While this approach constitutes an oversimplification of the complexities of extended-reach drilling, the information indicates that the area that could be reached by the greatest of these three values is outside the Sale 193 area.

Seismic-Survey Timing. At Point Lay, MMS discussed the potential of timing seismic surveys starting in the southern portion of the sale area before moving up the coast (north) behind the bowhead whale movement. We were advised not to do this, as the seismic activity to the south will make the whales skittish and could affect their coming close to shore. Thus, this alternative will not be further considered in this EIS. Timing of seismic surveying is addressed within the G&G permitting process. One of MMS's mitigation requirements is that seismic surveys are not conducted in the Chukchi Sea spring lead system before July 1.

Delay the Sale. A comment in Barrow suggested that the sale should be delayed until the release of the report from the National Science Foundation on its findings on the state of natural resources from its cruise on the U.S. Coast Guard Cutter *Healy*. Anadarko Petroleum suggested that we delay the sale to allow "other potential lessees sufficient time to obtain modern seismic data, explore opportunities to form partnerships, and develop a competitive knowledge that will aid in the realization of the full potential of this area." Either circumstance could delay the sale approximately 2 years, until 2009. The current Draft Proposed Program for 2007-2012 has lease sales in the Chukchi Sea Planning Area tentatively scheduled in 2010 and 2012. This alternative to delay the sale would be equivalent to cancelling Sale 193 as scheduled under the 2002-2007 5-Year Program with the next sale being considered in the Chukchi Sea Planning Area being the 2009 sale under the 2007-2012 5-Year Program. This alternative to delay the sale is equivalent to the Alternative II (No Lease Sale) analyzed in this EIS.

General Deferral. The USEPA suggested MMS consider removal of additional areas with sensitive fish and wildlife, subsistence, and cultural resources, and at a minimum, deferring areas until further research and studies are conducted to ensure development can occur without significant impacts to critical resources. As the USEPA suggestion identified no specific areas, we believe that the deferrals considered under

Alternatives III and IV of this EIS appropriately address the USEPA's concerns for the area considered under the Proposed Action.

Whale Country Deferral. The NSB suggested that any framework designed to protect areas critical to subsistence must encompass four geographic components: harvest areas, subsistence-use areas, areas of influence, and areas critical to the welfare of the subsistence species themselves. These typically are areas where the species are concentrated and particularly vulnerable to disturbance, such as calving areas, molting and brooding areas, and feeding areas. The Chukchi Sea is seasonal habitat for polar bears, seals, fish, waterfowl, gray whales, and beluga whales. It also functions as important habitat of the endangered bowhead whale, which migrates, engages in post-peak breeding, calves, feeds, and rears newly born calves in the region. The extent of this deferral area is large; it is actually a network of deferrals related to the four geographic components. The areas of Whale Country Deferral components discussed above within the proposed Chukchi Sea Sale 193 area are encompassed within the deferrals considered in Alternatives III and IV of this EIS.

25-Mile Buffer Deferral. The Secretary's Final Proposed OCS Leasing Program for 2007-2012 includes an alternative for a 25 Statute Mile Buffer Deferral in the Chukchi Sea Planning Area (USDOJ, MMS, 2006c:Fig. 2-1). An analysis for the 25-mi buffer deferral can be found in the 2007-2012 5-Year Program EIS. At the time of the draft EIS for Sale 193, it was not known whether the 25-mi buffer would be adopted by the Secretary and, therefore, the area was not excluded from Alternative I (Proposed Action).

II.B.3. Mitigation Measures Specific to the Lease-Sale Process for Sale 193.

II.B.3.a. Mitigation Measures Considered But Not Analyzed.

Numerous potential mitigation measures have been identified through the scoping efforts for many past lease sale EIS's. Studies were funded to provide information to evaluate some of these potential mitigation measures. Some of the potential mitigation measures were adopted or modified and adopted. Some measures were dropped from further consideration, when analysis indicated that the measures were not warranted or would have been ineffective.

II.B.3.b. Proposed Mitigation Measures Analyzed.

The potential mitigation measures for various resources associated with the Chukchi Sea were identified for each resource category analyzed in this EIS. Some of the potential mitigating measures were developed as the result of the scoping efforts accomplished over recent years for lease sales and for the continuing program in the Alaska OCS.

II.B.3.c. Existing Mitigation Measures.

Mitigation measures have been proposed, identified, evaluated, or developed through previous MMS lease-sale NEPA review and analysis processes. Many of these mitigation measures have been adopted and incorporated into regulations and guidelines governing OCS exploration, development, and production activities. All plans for OCS activities go through MMS review and approval to ensure compliance with established laws and regulations. Mitigation measures must be incorporated and documented in plans submitted to MMS. Operational compliance is enforced through the MMS on-site inspection program.

Mitigation measures that are a standard part of the MMS program require seasonal windows for seismic operations; and require surveys to detect and avoid archaeological sites and biologically sensitive areas.

Some MMS-identified mitigation measures are incorporated into OCS operations through cooperative agreements or efforts with industry and various State and Federal agencies.

II.B.3.c(1) Stipulations.

Stipulation No. 1 – Protection of Biological Resources. If previously unidentified biological populations or habitats that may require additional protection are identified in the lease area by the Regional Supervisor, Field Operations (RS/FO), the RS/FO may require the lessee to conduct biological surveys to determine the

extent and composition of such biological populations or habitats. The RS/FO shall give written notification to the lessee of the RS/FO's decision to require such surveys.

Based on any surveys that the RS/FO may require of the lessee or on other information available to the RS/FO on special biological resources, the RS/FO may require the lessee to:

- (1) Relocate the site of operations;
- (2) Establish to the satisfaction of the RS/FO, on the basis of a site-specific survey, either that such operations will not have a significant adverse effect upon the resource identified or that a special biological resource does not exist;
- (3) Operate during those periods of time, as established by the RS/FO, that do not adversely affect the biological resources; and/or
- (4) Modify operations to ensure that significant biological populations or habitats deserving protection are not adversely affected.

If any area of biological significance should be discovered during the conduct of any operations on the lease, the lessee shall immediately report such finding to the RS/FO and make every reasonable effort to preserve and protect the biological resource from damage until the RS/FO has given the lessee direction with respect to its protection.

The lessee shall submit all data obtained in the course of biological surveys to the RS/FO with the locational information for drilling or other activity. The lessee may take no action that might affect the biological populations or habitats surveyed until the RS/FO provides written directions to the lessee with regard to permissible actions.

Summary of the Effectiveness of Stipulation No. 1. The level of protection provided by this measure will depend on several factors:

- the size of population that might be subjected to adverse impacts and the number of individuals within the population that would be afforded protection by this stipulation;
- the overall size of habitat used by the resource of concern and the portion of that habitat that may be affected by offshore oil and gas operations; and
- the uniqueness of the population or habitat.

Thus, the effectiveness of the stipulation could vary widely. If only a few members of a large population or a small amount of a large habitat area were to be affected by oil and gas operations, the mitigative benefits would be minimal. However, if many individuals of a small population or most of the area of unique habitat is protected and the adverse effects are reduced or minimized because of this stipulation, then its effectiveness could be substantial. This stipulation lowers the potential adverse effects to lower trophic-level organisms, primarily unknown kelp communities, and other unique biological communities, that may be identified during oil and gas exploration or development activities and provided additional protection. It also would provide protection to fish habitat from potential disturbance associated with oil and gas exploration, development, and production. This stipulation does not change the level of impacts that may occur from a large oil spill.

Stipulation No. 2 – Orientation Program. The lessee shall include in any exploration or development and production plans submitted under 30 CFR 250.211 and 250.241 a proposed orientation program for all personnel involved in exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) for review and approval by the Regional Supervisor, Field Operations. The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns that relate to the sale and adjacent areas. The program shall address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals and provide guidance on how to avoid disturbance. This guidance will include the production and distribution of information cards on endangered and/or threatened species in the sale area. The program shall be designed to increase the sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which such personnel will be operating. The orientation program shall also include information concerning avoidance of conflicts with subsistence activities and pertinent mitigation.

The program shall be attended at least once a year by all personnel involved in onsite exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) and all supervisory and managerial personnel involved in lease activities of the lessee and its agents, contractors, and subcontractors.

The lessee shall maintain a record of all personnel who attend the program onsite for so long as the site is active, not to exceed 5 years. This record shall include the name and date(s) of attendance of each attendee.

Summary of the Effectiveness of Stipulation No. 2. This stipulation provides positive mitigating effects by requiring that all personnel involved in petroleum activities on the North Slope resulting from any leases issued from Sale 193 be aware of the unique environmental, social, and cultural values of the local Inupiat residents and their environment. This stipulation should help avoid damage or destruction of environmental, cultural, and archaeological resources through awareness and understanding of historical and cultural values. It also would help minimize potential conflicts between subsistence hunting and gathering activities and oil and gas activities that may occur. The extent of reduction offered by this stipulation is difficult to measure directly or indirectly.

This stipulation provides protection to fish (including the migration of fish), pinnipeds, polar bears, bowhead whales, gray whales, and beluga whales from potential disturbances associated with oil and gas exploration, development, and production by increasing the awareness of workers to their surrounding environment. It increases the sensitivity to and understanding by workers of the values, customs, and lifestyles of Native communities and reduces the potential conflicts with subsistence resources and hunting activities. This stipulation does not change the level of impacts that may occur from a large oil spill.

Stipulation No. 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 helps reduce or moderate the potential effects to water quality, lower trophic-level organisms, fish and fish migration, endangered species, marine mammals, etc. This stipulation would not likely change the level of impacts that may occur from a large oil spill.

Stipulation No. 4 – Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources. A lessee proposing to conduct exploration operations, including ancillary seismic surveys on a lease, during the periods and within the subsistence use areas related to bowhead whale, beluga whale, ice seals, walrus, and polar bears and their migrations and subsistence hunting as specified below, will be required to conduct a site-specific monitoring program approved by the Regional Supervisor, Field Operations (RS/FO); unless, based on the size, timing, duration, and scope of the proposed operations, the RS/FO, in consultation with appropriate agencies and co-management organizations, determines that a monitoring program is not necessary. Organizations currently recognized by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) for the co-management of the marine mammals resources are the North Slope Borough, the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, the Alaska Eskimo Walrus Commission, the Ice Seal Commission, and the Nanuk Commission. The RS/FO will provide the appropriate agencies and co-management organizations a

minimum of 30 but no longer than 60 calendar days to review and comment on a proposed monitoring program prior to approval. The monitoring program must be approved each year before exploratory drilling operations can be commenced.

The monitoring program will be designed to assess when bowhead and beluga whales, ice seals, walrus, and polar bears are present in the vicinity of lease operations and the extent of behavioral effects on these marine mammals due to these operations. In designing the program, the lessee must consider the potential scope and extent of effects that the type of operation could have on these marine mammals. Experiences relayed by subsistence hunters indicate that, depending on the type of operations some whales demonstrate avoidance behavior at distances of up to 35 mi. The program must also provide for the following:

- (1) Recording and reporting information on sighting of the marine mammals of concern and the extent of behavioral effects due to operations;
- (2) Coordinating the monitoring logistics beforehand with the MMS Bowhead Whale Aerial Survey Project (BWASP) and other mandated aerial monitoring programs;
- (3) Invite a local representative to be determined by consensus of the appropriate co-management organizations to participate as an observer in the monitoring program;
- (4) Submitting daily monitoring results to the RS/FO;
- (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 appropriate agencies and co-management organizations; and
- (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 appropriate agencies and co-management organizations.

The lessee will be required to fund an independent peer review of a proposed monitoring plan and the draft report on the results of the monitoring program for bowhead whales. The lessee may be required to fund an independent peer review of a proposed monitoring plan and the draft report on the results of the monitoring program for other co-managed marine mammal resources. This peer review will consist of independent reviewers who have knowledge and experience in statistics, monitoring marine mammal behavior, the type and extent of the proposed operations, and an awareness of traditional knowledge. The peer reviewers will be selected by the RS/FO from experts recommended by the appropriate agencies and co-management resource organizations. The results of these peer reviews will be provided to the RS/FO for consideration in final approval of the monitoring program and the final report, with copies to the appropriate agencies and co-management organizations.

In the event the lessee is seeking a Letter of Authorization (LOA) or Incidental Harassment Authorization (IHA) for incidental take from NMFS and/or FWS, the monitoring program and review process required under the LOA or IHA may satisfy the requirements of this stipulation. The lessee must advise the RS/FO when it is seeking an LOA or IHA in lieu of meeting the requirements of this stipulation and provide the RS/FO with copies of all pertinent submittals and resulting correspondence. The RS/FO will coordinate with the NMFS and/or FWS and will advise the lessee if the LOA or IHA will meet these requirements.

The MMS, NMFS, and FWS will establish procedures to coordinate results from site-specific surveys required by this stipulation and the LOA's or IHA's to determine if further modification to lease operations are necessary.

This stipulation applies to the areas and time periods listed below. This stipulation will remain in effect until termination or modification by the Department of the interior after consultation with appropriate agencies.

Subsistence Whaling and Marine Mammal Hunting Activities by Community

Barrow: Spring bowhead whaling occurs from April to June; Barrow hunters hunt from ice leads from Point Barrow southwestward along the Chukchi Sea coast to the Skull Cliff area; fall whaling occurs from August to October in an area circumscribed by a western boundary extending approximately 10 miles west of Barrow, a northern boundary 30 miles north of Barrow, then

southeastward to a point about 30 miles off Cooper Island, with an eastern boundary on the east side of Dease Inlet. Occasional use may extend eastward as far as Smith Bay and Cape Halkett. Beluga whaling occurs from April to June in the spring leads between Point Barrow and Skull Cliff; later in the season, belugas are hunted in open water around the barrier islands off Elson Lagoon. Walrus are harvested from June to September from west of Barrow southwestward to Peard Bay. Polar bear are hunted from October to June generally in the same vicinity used to hunt walrus. Seal hunting occurs mostly in winter, but some open-water sealing is done from the Chukchi coastline east as far as Dease Inlet and Admiralty Bay in the Beaufort Sea.

Wainwright: Bowhead whaling occurs from April to June in the spring leads offshore of Wainwright; with whaling camps sometimes are as far as 10 to 15 miles from shore. Wainwright hunters hunt beluga whales in the spring lead system from April to June but only if no bowheads are in the area. Later in the summer, from July to August, belugas can be hunted along the coastal lagoon systems. Walrus hunting occurs from July to August at the southern edge of the retreating pack ice. From August to September walrus can be hunted at local haulouts with the focal area from Milliktagvik north to Point Franklin. Polar bear hunting occurs primarily in the fall and winter around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island.

Point Lay: Because Point Lay's location renders it unsuitable for bowhead whaling, beluga whaling is the primary whaling pursuit. Beluga whales are harvested from the middle of June to the middle of July. The hunt is concentrated in Naokak and Kukpowruk Passes south of Point Lay where hunters use boats to herd the whales into the shallow waters of Kasegaluk Lagoon where they are hunted. If the July hunt is unsuccessful, hunters can travel as far north as Utukok Pass and as far south as Cape Beaufort in search of whales. When ice conditions are favorable, Point Lay residents hunt walrus from June to August along the entire length of Kasegaluk Lagoon, south of Icy Cape, and as far as 20 miles offshore. Polar bear are hunted from September to April along the coast rarely more than 2 miles offshore.

Point Hope: Bowhead whales are hunted from March to June from whaling camps along the ice edge south and southeast of the point. The pack-ice lead is rarely more than 6 to 7 miles offshore. Beluga whales are harvested from March to June in the same area used for the bowhead whale hunt. Beluga whales can also be hunted in the open water later in the summer from July to August near the southern shore of Point Hope close to the beaches, as well as areas north of the point as far as Cape Dyer. Walrus is harvested from May to July along the southern shore of the point from Point Hope to Akoviknak Lagoon. Point Hope residents hunt polar bear primarily from January to April and occasionally from October to January in the area south of the point and as far out as 10 miles from shore.

Summary of the Effectiveness of Stipulation No. 4. This stipulation provides site-specific information about the migration of bowhead whales and other marine mammals that could occur from oil and gas activities from the proposed lease sale. The information can be used to evaluate the threat of harm to the species and provides immediate information about the activities of bowhead whales, other marine mammals, and their response to specific events. This stipulation helps address NMFS concerns and recommendations to reduce potential effects to exploration activities. This stipulation also contributes incremental and important information to ongoing whale research and monitoring efforts and to the information database for bowhead whales. This stipulation helps reduce effects to subsistence-harvest patterns and to the overall sociocultural systems that place special value to bowhead whale harvests and the traditional activities of sharing this harvest with the other members of the community. This stipulation helps provide mitigation to potential effects of oil and gas activities to the local Native whale hunters and subsistence users. It is considered to be a positive action by the Native community under environmental justice.

Stipulation No. 5 – Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Marine Mammal Subsistence-Harvesting 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 and other marine mammal subsistence hunting). This stipulation applies to leases within the subsistence deferral areas (Corridor I and

Corridor II) for offshore exploration, development, and production activities, and applies to all leases for associated activities, such as vessel and aircraft traffic that transit the subsistence deferral areas, or that occur nearshore in support of those leases.

Prior to submitting an exploration plan or development and production plan (including associated oil-spill response plans) to the MMS for activities proposed during the bowhead whale migration period and the critical times and locations listed below for other marine mammals, the lessee shall consult with the North Slope Borough, and with directly affected subsistence communities (Barrow, Point Lay, Point Hope, or Wainwright) and co-management organizations to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures that could be implemented by the operator to prevent unreasonable conflicts. Organizations currently recognized by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) for the co-management of the marine mammals resources are the North Slope Borough, the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, the Alaska Eskimo Walrus Commission, the Ice Seal Commission, and the Nanuk Commission. 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 marine mammal 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. The lessee 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 response plans) to the directly affected communities and the appropriate co-management organizations at the time the plans 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, NMFS, FWS, the appropriate co-management organizations, and any communities that could be directly affected directly by the proposed activity, may request that the RS/FO assemble a group consisting of representatives from the parties to specifically address the conflict and attempt to resolve the issues before the RS/FO makes 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. Activities on a lease may be restricted if 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-harvesting activities occur generally in the areas and time periods listed below.

Subsistence Whaling and Marine Mammal Hunting Activities by Community

Barrow: Spring bowhead whaling occurs from April to June; Barrow hunters hunt from ice leads from Point Barrow southwestward along the Chukchi Sea coast to the Skull Cliff area; fall whaling occurs from August to October in an area circumscribed by a western boundary extending approximately 10 miles west of Barrow, a northern boundary 30 miles north of Barrow, then southeastward to a point about 30 miles off Cooper Island, with an eastern boundary on the east side of Dease Inlet. Occasional use may extend eastward as far as Smith Bay and Cape Halkett. Beluga whaling occurs from April to June in the spring leads between Point Barrow and Skull Cliff; later in the season, belugas are hunted in open water around the barrier islands off Elson Lagoon. Walrus are harvested from June to September from west of Barrow southwestward to

Peard Bay. Polar bears are hunted from October to June generally in the same vicinity used to hunt walrus. Seal hunting occurs mostly in winter, but some open-water sealing is done from the Chukchi coastline east as far as Dease Inlet and Admiralty Bay in the Beaufort Sea.

Wainwright: Bowhead whaling occurs from April to June in the spring leads offshore of Wainwright; with whaling camps sometimes are as far as 10 to 15 miles from shore. Wainwright hunters hunt beluga whales in the spring lead system from April to June but only if no bowheads are in the area. Later in the summer, from July to August, belugas can be hunted along the coastal lagoon systems. Walrus hunting occurs from July to August at the southern edge of the retreating pack ice. From August to September walrus can be hunted at local haulouts with the focal area from Milliktagvik north to Point Franklin. Polar bear hunting occurs primarily in the fall and winter around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island.

Point Lay: Because Point Lay's location renders it unsuitable for bowhead whaling, beluga whaling is the primary whaling pursuit. Beluga whales are harvested from the middle of June to the middle of July. The hunt is concentrated in Naokak and Kukpowruk Passes south of Point Lay, where hunters use boats to herd the whales into the shallow waters of Kasegaluk Lagoon where they are hunted. If the July hunt is unsuccessful, hunters can travel as far north as Utukok Pass and as far south as Cape Beaufort in search of whales. When ice conditions are favorable, Point Lay residents hunt walrus from June to August along the entire length of Kasegaluk Lagoon, south of Icy Cape, and as far as 20 miles offshore. Polar bears are hunted from September to April along the coast rarely more than 2 miles offshore.

Point Hope: Bowhead whales are hunted from March to June from whaling camps along the ice edge south and southeast of the point. The pack-ice lead is rarely more than 6 to 7 miles offshore. Beluga whales are harvested from March to June in the same area used for the bowhead whale hunt. Beluga whales can also be hunted in the open water later in the summer from July to August near the southern shore of Point Hope close to the beaches, as well as areas north of the point as far as Cape Dyer. Walrus is harvested from May to July along the southern shore of the point from Point Hope to Akoviknak Lagoon. Point Hope residents hunt polar bear primarily from January to April and occasionally from October to January in the area south of the point and as far out as 10 miles from shore.

Summary of the Effectiveness of Stipulation No. 5. 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 lessee meet with local communities and subsistence groups to resolve potential conflicts. This stipulation reduces the potential adverse effects from the proposed sale to subsistence-harvest patterns, sociocultural systems, and to environmental justice. The consultations required by this stipulation ensure that the lessee, including contractors, consult and coordinate both the timing and siting of events with subsistence users.

This stipulation has proven to be effective in the Beaufort Sea Planning Area 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 would also apply to development and production activities and could reduce the potential adverse effects to subsistence-harvesting activities.

Stipulation No. 6 – Pre-Booming Requirements for Fuel Transfers. Fuel transfers (excluding gasoline transfers) of 100 barrels or more occurring three 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. The lessee's oil-spill-response plans must include procedures for the pretransfer booming of the fuel barge(s).

Summary of the Effectiveness of Stipulation No. 6. This stipulation would lower the potential effects to bowhead whales, water quality, lower trophic-level organisms, other marine mammals, subsistence resources and hunting, and sociocultural systems by providing rapid response to potential fuel spills. By

containing any spill within the boom area, this stipulation would reduce the chance of any fuel spill contacting a bowhead whale, the risk of harm to a whale, and the risk that a harvested whale may be tainted from a potential spill.

Stipulation No. 7 - Measures to Minimize Effects to Spectacled and Steller's Eiders during Exploration Activities. This stipulation would minimize the likelihood that Steller's and spectacled eiders would strike drilling structures and provide additional protection to listed eiders using the Ledyard Bay Spectacled Eider Critical Habitat Area and the Spring Lead System. These measures address lighting of lease structures/vessels and any exploration/delineation drilling activities proposed to occur within the Ledyard Bay Critical Habitat Area and the Spring Lead System during times listed eiders are present.

A) General conditions: The following conditions apply to all exploration activities.

- 1) An Exploration Plan must include a plan for recording and reporting bird strikes. All bird collisions (with vessels, aircraft, or structures) shall be documented and reported within 3 days to MMS. Minimum information will include species, date/time, location, weather, and, if a vessel is involved, it's operational status when the strike occurred. Bird photographs are not required, but would be helpful in verifying species. Lessees are advised that the USFWS does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.
 - 2) Exploration program support vessels will minimize operations that require high-intensity work lights, especially within the 20-m bathymetric contour. High-intensity lights will be turned off in inclement weather; however, navigation lights, deck lights, and interior lights could remain on for safety.
 - 3) An Oil Spill Response Vessel must be on-site when a rig is actively drilling within the Spring Lead System (April 15-June 10) or the Ledyard Bay Critical Habitat Area (July 1-November 15).
 - 4) Exploration program vessels working in or actively drilling in the Spring Lead System (April 15-June 10) or Ledyard Bay Critical Habitat Area (June 11-November 15) will have ready access to wildlife hazing equipment (including at least 3 *Breco* buoys or similar devices). This equipment could be on-board, be on an on-site OSRV, or be in Point Lay or Wainwright so long as it is kept readily accessible to oil-spill response personnel that are trained in its use.
 - 5) Aircraft supporting drilling operations will avoid operating below 1,500 feet ASL over the Spring Lead System (April 15-June 10) or Ledyard Bay Critical Habitat Area (July 1-November 15) to the maximum extent practicable. If weather prevents attaining this altitude, aircraft will use pre-designated flight routes at the outer margin of the Ledyard Bay Critical Habitat Area. Pre-designated flight routes will be established by the lessee and MMS, in collaboration with the FWS, during prior to review of the Exploration Plan. Route or altitude deviations for emergencies or human safety shall be reported within 24 hours to MMS.
- B) Drill Structure Lighting Protocol:** Lessees must adhere to lighting requirements for all exploration or delineation structures so as to minimize the likelihood that migrating marine and coastal birds will strike these structures. Lessees are required to implement lighting requirements aimed at minimizing the radiation of light outward from exploration/delineation structures to minimize the likelihood that birds will strike those structures. These requirements establish a coordinated process for a performance-based objective rather than pre-determined prescriptive requirements. The performance-based objective is to minimize the radiation of light outward from exploration/delineation structures. Measures to be considered include but need not be limited to the following:
- Shading and/or light fixture placement to direct light inward and downward to living and work structures while minimizing light radiating upward and outward;
 - Types of lights;
 - Adjustment of the number and intensity of lights as needed during specific activities;
 - Dark paint colors for selected surfaces;

- Low-reflecting finishes or coverings for selected surfaces; and
- Facility or equipment configuration.

Lessees are encouraged to consider other technical, operational and management approaches that could be applied to their specific facility and operation to reduce outward light radiation. These requirements apply to all Chukchi Sea OCS Lease Sale 193 activities conducted between April 15 and November 15 of each year.

Nothing in this protocol is intended to reduce personnel safety or prevent compliance with other regulatory requirements (e.g., U.S. Coast Guard or Occupational Safety and Health Administration) for marking or lighting of equipment and work areas.

- C) Exploratory Drilling Operations:** For the purpose of this stipulation, the spring lead system is defined as the Ledyard Bay Critical Habitat Area as well as the area landward from an imaginary line extending from the outer corner of the Critical Habitat Area (70°20'00"N x 164°00'00"W) extending northeast to the southeastern-most corner of the Lease Sale 193 Sale Area (71°39'35"N x 156°00'00"W) and the area landward of an imaginary line drawn between Point Hope and the other outer corner of the Ledyard Bay Critical Habitat Area (69°12'00"N x 166°13'00" W).

1) Spring Lead System

Vessels associated with drilling operations should avoid operating within the spring lead system to the maximum extent practicable. The following condition applies to any vessels associated with exploratory and delineation drilling operations that operate in the Spring Lead System (April 15-June 10).

- a) Lessees are required to provide information regarding their operations within the spring lead system upon request of MMS. MMS may request information regarding number of vessels and their dates/points of entry into and exit from the spring lead system.

2) Ledyard Bay Critical Habitat Area

Except for emergencies or human/navigation safety, vessels associated with exploration drilling operations will minimize travel within the Ledyard Bay Critical Habitat Area to the maximum extent practicable. Exploration vessel travel within the Ledyard Bay Critical Habitat Area for emergencies or human/navigation safety shall be reported within 24 hours to MMS.

The following condition applies to any exploratory and delineation drilling operations proposed to occur in the Ledyard Bay Critical Habitat Area (July 1–November 15).

- a) The drill rig and support vessels must enter the Ledyard Bay Critical Habitat Area from the northwest and proceed directly to the drill site. Support vessels will remain in close proximity to the drill rig while providing support and exit the drill rig vicinity to the northwest until out of the Critical Habitat Area. Deviations from this routing shall be reported within 24 hours to MMS.

Summary of the Effectiveness of Stipulation No. 7. This stipulation was developed jointly by MMS and FWS in accordance with the MMS Biological Evaluation (BE) and the FWS Biological Opinion (BO) for Chukchi Sea Lease Sale 193. The FWS BO specified reasonable and prudent measures necessary and appropriate to minimize potential adverse impacts to threatened eiders and designated critical habitat. To be exempt from the prohibitions of Section 9 of the ESA, MMS must comply with the terms and conditions identified in the BO. Correspondence related to this ESA Section 7 consultation is in Appendix C. The MMS BE is available at the MMS website (http://www.mms.gov/alaska/ref/Biological_opinionsevaluations.htm) or from MMS. The FWS BO is available at the same website or from the FWS Field Office in Fairbanks, Alaska.

Stipulation 7 may be modified as a result of future ESA Section 7 consultations with the FWS. Comparable measures for structures related to development and production activities would be identified by FWS during ESA consultations on specific Development and Production Plans.

II.B.3.c(2) Notice to Lessees. Notice to Lessees (NTL) No. 05-A03, Archaeological Survey and Evaluation for Exploration and Development Activities.

This NTL language is standard and applies to OCS activities in the Chukchi Sea. The purpose of this NTL is to provide guidance for the lease owner/operator of performance standards for conducting and evaluating archaeological surveys, reports, and reporting procedures to the MMS, Alaska Outer Continental Shelf (OCS), Field Operations (FO) office. It is issued to clarify and interpret requirements contained in regulations and does not impose additional requirements.

This NTL is issued pursuant to regulations at 30 CFR 250.194; 30 CFR 250.201; 30 CFR 250.203; 30 CFR 250.204; 30 CFR 250.1007(a)(5); and 30 CFR 250.1010(c) and supersedes NTL 00-A03, dated February 7, 2000.

Before beginning drilling, facility construction, or pipeline rights-of-way (ROW) activities, an archaeological survey and analysis may be required to be conducted, to evaluate the existence and location of any submerged archaeological resources, which could be impacted by proposed OCS operations. An Archaeological Resource Report is a document prepared by an operator or applicant and submitted to the MMS Regional Supervisor for Field Operations (RS/FO). The report is an analysis of geophysical data for indications of potential archaeological resources. The report is for prehistoric and /or historic resources, as determined by the MMS RS/FO, and covers the area of proposed operations.

The MMS RS/FO may require pre-exploratory and pre-development archaeological investigations and evaluation if the Regional Director (RD) determines that submerged archaeological resources may exist on or near lease areas under MMS authority.

Potential submerged archaeological resources range from historic to prehistoric. Historic resources include man-made objects or structures older than 50 years, such as shipwrecks, submerged structures, and aircraft. Prehistoric archaeological resources may occur in areas that were sub-aerially exposed during the low stand of sea level approximately 13,000 years before present (generally 60 meters below sea level on the Alaska OCS). Relict terrestrial landforms such as preserved levees or terraces associated with paleo-river channels, river confluences, ponds, lakes, lagoons, or paleo-shorelines are areas where archaeological sites are most likely to occur.

When notified by the RD that an archaeological resource may exist in the lease area, an archaeological survey must be performed, and an archaeological report must be included in the Exploration Plan (EP) and/or Development and Production Plan (DPP) submittal, and/or pipeline ROW permit application. See Map 7, Archaeology Blocks and Locations of Shipwrecks in the Chukchi Sea Sale 193 Planning Area for specific blocks in the Chukchi Sea Planning Area on which an archaeological resource may exist and for which an archaeological report will be required (see also Table III.C.18, Shipwrecks in Chukchi Sea Planning Area). Activities associated with leases that affect the seafloor have the potential to disturb prehistoric archaeological resources in water depths of less than 60 meters. This is based upon past sea level history only. No prehistoric resources are expected in some areas of the shelf in water depths less than 60 meters, where: (1) there are no Quaternary sediments and (2) where extensive ice gouging has reworked the Quaternary section, but these areas are not well defined and will have to be determined on a case-by-case basis. High resolution seismic data from site clearance surveys will reveal these features and sediment thickness. The likelihood of historic resources such as shipwrecks, abandoned relics of historic importance, or submerged airplanes, is determined by historical records and their areas are tentatively identified in the Alaska Shipwreck Database. There may be other occurrences of historic resources, and these will be determined during survey work. Activities that have the potential to disturb offshore archaeological resources include: (1) anchoring; (2) pipeline trenching; (3) excavating well cellars; (4) emplacement of bottom-founded platforms; and (5) use of bottom cables for seismic data collection.

More information on archaeological resources may be found in the MMS Handbook for Archaeological Resource protection, which is available upon request or on the MMS web page at <http://www.mms.gov/adm/rn239.pdf>. The complete text of NTL No. 05-A03 specifying archaeological survey requirements, proper report format and content, and timelines can be found at <http://www.mms.gov/alaska/regs/NTL%202005-A031.pdf>.

II.B.3.c(3) Information to Lessees Clauses. Information to Lessees (ITL) clauses 1 through 15 are standard and apply to OCS activities in the Chukchi Sea. The primary purpose of an ITL is to provide lessees with additional information related to mitigating potential adverse impacts from future oil and gas activities. Some ITL's provide information about issues and concerns related to particular environmental or sociocultural resources. Some ITL's provide information on how lessees might plan their activities to meet MMS requirements or reduce potential impacts. Some ITL's provide information about the requirements or mitigation required by other Federal and State agencies. To the extent that the ITL clauses alert and inform lessees and their contractors about mitigative measures, the ITL clauses are effective in lowering potential impacts. For analysis purposes, they are considered part of the proposed action and alternatives for the Chukchi Sea Sale 193.

- No. 1 – Information on Community Participation in Operations Planning
- No. 2 – Information on Bird and Marine Mammal Protection
- No. 3 – Information on River Deltas
- No. 4 - Information on Endangered Whales and MMS Monitoring Program
- No. 5 – Information on the Availability of Bowhead Whales for Subsistence-Hunting Activities
- No. 6 – Information on High-Resolution Geological and Geophysical Survey Activity
- No. 7 – Information on the Spectacled Eider and Steller's Eider
- No. 8 – Information on Sensitive Areas to be Considered in Oil-Spill-Response Plans
- No. 9 – Information on Coastal Zone Management
- No. 10 – Information on Navigational Safety
- No. 11 – Information on Offshore Pipelines
- No. 12 – Information on Discharge of Produced Waters
- No. 13 – Information on Use of Existing Pads and Islands
- No. 14 – Information on Planning for Protection of Polar Bears
- No. 15 – Possible listing of Polar Bear under ESA
- No. 16 – Archaeological and Geological Hazards Reports and Surveys
- No. 17 – Response Plans for Facilities Located Seaward of the Coast Line
- No. 18 – Oil Spill Financial Responsibility for Offshore Facilities
- No. 19 – Good Neighbor Policy
- No. 20 – Rentals/Minimum Royalties and Royalty Suspension Provisions
- No. 21 – MMS Inspection and Enforcement of Certain Coast Guard Regulations
- No. 22 – Statement Regarding Certain Geophysical Data
- No. 23 – Affirmative Action Requirements
- No. 24 – Bonding Requirements

No. 1 - Information on Community Participation in Operations Planning. Lessees are encouraged to bring one or more residents of communities in the area of operations into their planning process. Local communities often have the best understanding of how oil and gas activities can be conducted safely in and around their area without harming the environment or interfering with community activities. Involving local community residents in the earliest stages of the planning process for proposed oil and gas activities can be beneficial to the industry and the community. Community representation on management teams, developing plans of operation, oil-spill response plans, and other permit applications can help communities understand permitting obligations and help the industry to understand community values and expectations for oil and gas operations being conducted in and around their area.

No. 2 - Information on Bird and Marine Mammal Protection. Lessees are advised that during the conduct of all activities related to leases issued as a result of this sale, the lessee and its agents, contractors, and subcontractors will be subject to the provisions of the following laws, among others: the Marine Mammal Protection Act (MMPA) of 1972, as amended (16 U.S.C. 1361 et seq.); the Endangered Species Act (ESA), as amended (16 U.S.C. 1531 et seq.); and applicable International Treaties.

Lessees and their contractors should be aware that disturbance of wildlife could be determined to constitute harm or harassment and thereby be in violation of existing laws and treaties. With respect to endangered species and marine mammals, disturbance could be determined to constitute a "taking" situation. Under the ESA, the term "take" is defined to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Under the MMPA, "take" means "harass, hunt, capture, collect, or kill or attempt to harass, hunt, capture, or kill any marine mammal." Violations under

these Acts and applicable Treaties will be reported to National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (FWS), as appropriate.

Incidental taking of marine mammals and endangered and threatened species is allowed only when the statutory requirements of the MMPA, the ESA, or both, depending on the species that is taken, are met. Section 101(a)(5) of the MMPA, as amended, (16 U.S.C. 1371(a)(5)) provides a mechanism for allowing, upon request and during periods of not more than 5 consecutive years each, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographic region, provided that NMFS or FWS finds that the total of such taking during each 5-year (or less) period would have no more than a negligible impact on such species or stock and will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses.

Applicants can receive authorization to incidentally, but not intentionally, take marine mammals under the MMPA through two types of processes: the Letter of Authorization (LOA) process and the Incidental Harassment Authorization (IHA) process. In either case, under the MMPA, incidental take of marine mammals is prohibited unless authorization is obtained by those proposing the activity, whether or not the marine mammals are endangered or threatened.

Lessees are advised that, if marine mammals may be taken by harassment, injury, or mortality as a result of exploration activities, specific regulations and LOA's must be applied for and in place or IHA's must be obtained by those proposing the activity in order to allow the incidental take of marine mammals whether or not they are endangered or threatened. The regulatory process may require 1 year or longer; the IHA process takes about 5 months after receipt of a complete application.

Based on guidance from the National Oceanographic and Atmospheric Administration (NOAA) Fisheries' Office of Protected Resources web site, if the applicant can show that: (a) there is no potential for serious injury or mortality; or, (b) the potential for serious injury or mortality can be negated through mitigation requirements that could be required under the authorization, the applicant should apply for an IHA and does not need an LOA for the activity.

If the potential for serious injury and/or mortalities exists and no mitigating measures are available to prevent this form of 'take' from occurring, to receive authorization for the take, the applicant must obtain an LOA. The LOA requires that regulations be promulgated and published in the *Federal Register* outlining: (a) permissible methods and the specified geographical region of taking; (b) the means of effecting the least practicable adverse impact on the species or stock and its habitat and on the availability of the species or stock for subsistence uses; and c) requirements for monitoring and reporting, including requirements for the independent peer review of proposed monitoring plans where the proposed activity may affect the availability of a species or stock for taking for subsistence uses.

Under the MMPA, of those marine mammal species that occur in Alaskan waters, NMFS is responsible for species of the order Cetacea (whales and dolphins) and the suborder Pinnipedia (seals and sea lions) except walruses; FWS is responsible for polar bears, sea otters, and walruses. Requests for Incidental Take Authorizations (ITA's) should be directed towards the appropriate agency. Procedural regulations implementing the provisions of the MMPA are found at 50 CFR Part 18.27 for the FWS and at 50 CFR Part 216 for NMFS.

If an applicant is requesting authorization for the incidental, but not intentional taking, of a marine mammal that is the responsibility of NMFS, a written request must be submitted to the NOAA Fisheries Office of Protected Resources and the appropriate NMFS Regional Office where the specified activity is planned. If an applicant is requesting authorization for the incidental, but not intentional, taking of a marine mammal that is the responsibility of FWS, a written request must be submitted to the FWS Regional Office where the specific activity is planned. More information on this process, and application materials, are available from the NOAA Fisheries Office of Protected Resources website (www.nmfs.noaa.gov/prot_res/PR2/Small_Take/smalltake.info.htm).

According to NOAA Fisheries Small Take web site, most LOA's and IHA's to date have involved the incidental harassment of marine mammals by noise. Activities with the greatest potential to harass by noise include seismic airguns, ship and aircraft noise, high-energy sonars, and explosives detonations.

Please note that the NOAA Fisheries web site on small-take authorizations indicates the following timetables for LOA and IHA decisions: "Decisions on LOA applications (includes two comment periods, possible public hearings and consultations) may take from 6-12 months. The IHA decisions normally involve one comment period and, depending on the issues and species involved, can take anywhere from 2-6 months" (www.nmfs.noaa.gov/prot_res/PR2/Small_Take/smalltake_info.htm#applications).

Section 7(b)(4) of the ESA allows for the incidental taking of endangered and threatened species under certain circumstances. If a marine mammal species is listed as endangered or threatened under the ESA, the requirements of both the MMPA and the ESA must be met before the incidental take can be allowed.

Of particular concern is disturbance at major wildlife-concentration areas, including bird colonies, marine mammal haulout and breeding areas, and wildlife refuges and parks. Maps depicting major wildlife-concentration areas in the lease area are available from the MMS Regional Supervisor, Field Operations. Lessees also are encouraged to confer with FWS and NMFS in planning transportation routes between support bases and lease holdings.

Lessees also should exercise particular caution when operating in the vicinity of species that are not listed under the ESA but are proposed for listing, designated as candidates for listing, or are listed as a "Species of Concern" or whose populations are believed to be in decline, such as the yellow-billed loon, walrus, and polar bear.

Generally, behavioral disturbance of most birds and mammals found in or near the sale area would be unlikely if aircraft and vessels maintain at least a 1-mile horizontal distance and aircraft maintain at least a 1,500-foot (ft) vertical distance above known or observed wildlife-concentration areas, such as seabird colonies, the spring lead system, and marine mammal haulout and breeding areas.

For the protection of endangered whales and marine mammals throughout the lease area, MMS recommends that all aircraft operators maintain a minimum 1,500-ft altitude when in transit between support bases and exploration sites. The MMS encourages lessees and their contractors to minimize or reroute trips to and from the leasehold by aircraft and vessels when endangered whales are likely to be in the area.

Human safety will take precedence at all times over these recommendations.

No. 3 - Information to Lessees on River Deltas. Lessees are advised that certain river deltas of the Chukchi Sea coastal plain (such as the Kukpowruk River Delta) have been identified by the U.S. Fish and Wildlife Service (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. 4 - 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 and plans to conduct aerial monitoring of marine mammals in the Chukchi 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 may also begin a similar program in the Chukchi Sea.

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 Regional Supervisor, Field Operations (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 ancillary activities, conducted pursuant to 30 CFR 250.207, 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's 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 250.172. Any such suspensions may be terminated when the RS/FO determines that circumstances which justified the ordering of suspension no longer exist.

No. 5 - Information on the Availability of Bowhead Whales for Subsistence Hunting Activities.

Lessees are advised that the National Marine Fisheries Service (NMFS) issues regulations for incidental take of marine mammals, including bowhead whales. Incidental Take Authorizations (ITA's) are issued, and 5-year incidental take regulations are promulgated, only upon request and NMFS must be in receipt of an application prior to initiating either the regulatory or ITA process. Incidental takes of bowhead whales are allowed only if a Letter of Authorization (LOA) or an Incidental Harassment Authorization (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, 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 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. 6 - Information on Seismic Survey Activity. Lessees are advised of the potential effect of geophysical activity to bowhead whales, other marine mammals, and subsistence hunting activities. High-resolution seismic surveys are distinguished from 2D/3D seismic surveys by the magnitude of the energy source used in the survey, the size of the survey area, the number and length of arrays used, and duration of the survey period. High-resolution seismic surveys are typically conducted after a lease sale in association with a specific exploration or development program or in anticipation of future lease sale activity.

Lessees are advised that all seismic survey activity conducted in Chukchi Sea Planning Area, either under the geological and geophysical (G&G) permit regulations at 30 CFR 251 or as an ancillary activity in support of an exploration plan or development and production plan under 30 CFR 250, is subject to environmental and regulatory review by the MMS. The MMS has standard mitigating measures that apply to these activities, and lessees are encouraged to review these measures before developing their applications for G&G permits or planning ancillary activities on a lease. Copies of the nonproprietary portions of all G&G permits applications will be provided by MMS to appropriate agencies, co-management organizations, and directly affected communities. Organizations currently recognized by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) for the co-management of the marine mammals resources are the North Slope Borough, the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, the Alaska Eskimo Walrus Commission, and the Nanuk Commission. The MMS may impose restrictions (including the timing of operations relative to open water) and other requirements (such as having a locally approved coordinator on board) on seismic surveys to minimize unreasonable conflicts between the seismic survey activities and subsistence whaling activities.

Lessees and applicants are advised that MMS will require any proposed seismic activities to be coordinated with the appropriate agencies, co-management organizations, and directly affected subsistence communities to identify potential conflicts and develop plans to avoid these conflicts. Copies of the results of any required monitoring plans will be provided by MMS to the NSB, directly affected subsistence communities, and appropriate agencies and subsistence organizations for comment.

No. 7 - 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 U.S. Fish

and Wildlife Service (FWS) and are protected by the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

Spectacled eiders and Steller's eiders are present in the Chukchi Sea during spring migration in May and June. Males return to the open sea in late June, while nesting females remain on the arctic coastal tundra until late August or early September. Molting eiders occur in certain offshore areas until freeze-up (typically in November). Onshore activities related to OCS exploration, development, and production during the summer months (May-September) may affect nesting spectacled eiders and Steller's eiders.

Lessees are advised that exploration and development and production plans submitted to MMS will be reviewed by the FWS to ensure that spectacled eider, Steller's eider, and their habitats are protected. For the proposed Lease Sale 193, MMS specifically requested an incremental Section 7 consultation with the FWS. The MMS consulted with FWS on the potential effects of leasing and seismic/exploration activities. As few details are known regarding the specific location/design of a future development, that stage of the process will require further consultation with the FWS. To allow this stepwise approach, FWS found that the leasing and seismic/exploration stage of the project would not result in a jeopardy determination to either the Steller's eider or spectacled eider nor would adverse modification of spectacled eider critical habitat occur.

The FWS also concluded that there "is a reasonable likelihood that the entire action will not violate Section 7(a)(2) of the [Endangered Species] Act." Section 7(a)(2) of the Act requires that Federal Agencies ensure their actions are not likely to jeopardize the continued existence of any endangered or threatened species or adversely modify designated critical habitat. Lessees are advised that future development projects arising from Lease Sale 193 are subject to Section 7 consultation with the FWS and a future project would not be authorized by MMS if it results in jeopardy or adverse modification of designated critical habitat as determined by FWS.

No. 8 - Information on Sensitive Areas to be Considered in the Oil-Spill Response Plans (OSRP).

Lessees are advised that certain areas are especially valuable for their concentrations of marine birds, marine mammals, fishes, other biological resources, or cultural resources, and for their importance to subsistence harvest activities, and should be considered when developing OSRP's. Coastal aggregations of polar bears during the open water/broken-ice period are particularly vulnerable to the effects of an oil spill, which lessees must account for in their OSRP's. Identified areas and time periods of special biological and cultural sensitivity for the Chukchi Sea include:

- 1) Elson Lagoon;
- 2) Barrow Polar Bear Aggregation Area, August-October;
- 3) Spring Lead System April-June;
- 4) Peard Bay/Franklin Spit;
- 5) Kuk Lagoon;
- 6) Icy Cape and associated Barrier Islands;
- 7) Kasegaluk Lagoon and Naokok, Kukpowruk, Akunik, and Utukok Passes through the Barrier Islands;
- 8) Ledyard Bay Critical Habitat Area;
- 9) Cape Lisburne, May-September;
- 10) Marryat Inlet;
- 11) Cape Thompson, May-September;
- 12) On-and offshore waters from Point Hope to Cape Thompson, including Aiautak and Akoviknak Lagoons;
- 13) Kugrua River, May-October;
- 14) Kuchiak River, Jan-Dec;
- 15) Kuk River, May-October;
- 16) Kokolik River, May-October;
- 17) Kukpowruk River, May-October;
- 18) Pitmegea River, May-October; and
- 19) Utukok River, May-October.

These areas are among areas of special economic or environmental importance required by 30 CFR 254.26 to be considered in the OSRP. Lessees are advised that they have the primary responsibility for identifying these areas in their OSRP's and for providing specific protective measures. Additional areas of special economic or environmental importance may be identified during review of exploration plans and development and production plans.

Industry should consult with U.S. Fish and Wildlife Service or State of Alaska personnel to identify specific environmentally sensitive areas within National Wildlife Refuges or state special areas which should be considered when developing a project-specific OSRP.

Consideration should be given in an OSRP as to whether use of dispersants is an appropriate defense in the vicinity of an area of economic or environmental importance. Lessees are advised that prior approval must be obtained before dispersants are used.

No. 9 – Information on Coastal Zone Management. The MMS advises lessees that under the Coastal Zone Management Act (CZMA) (16 U.S.C. 1451 et. seq., Section 307), as amended, a State with an approved Coastal Zone Management (CZM) Plan reviews certain outer continental shelf (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 CZMA effective February 6, 2006. These revised regulations were published in the *Federal Register* on January 5, 2006, at 71 *FR* 788, et seq.

The Alaska Coastal Management Plan includes statewide standards found in 11 AAC 112 and enforceable policies found within approved coastal district programs. For the Chukchi Sea OCS mineral lease sales, the enforceable policies of the North Slope Borough Coastal Management Program and the statewide standards are applicable.

No. 10 - 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 U.S. Coast Guard (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 OCS Lands Act, 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. 11 - 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 (MOU), dated December 10, 1996, concerning the design, installation, and maintenance of offshore pipelines. See also 30 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. 12 - 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 U.S. Environmental Protection Agency (USEPA), and may also include a zero-discharge requirement on Federal tracts within the ten-meter contour.

No. 13 - Information on Use of Existing Pads and Islands. The MMS encourages lessees to use existing pads, natural and gravel islands, and other infrastructure in support of proposed exploration, development, and production activities wherever feasible.

No. 14 - Information on Planning for Protection of Polar Bears. Polar bears are part of a dynamic rather than a static system. Changes in their distributions and populations in recent years indicate that adaptive management is required to adequately mitigate potential impacts to their populations (i.e., specific mitigation measures developed today may not be applicable 5, 10, or 20 years from now). The U.S. Fish and Wildlife Service (FWS) is the management agency responsible for polar bear management; as such, they have the most current information about the status of polar bear populations, the issues facing them, and the most recent research findings applicable to them. Therefore, MMS will be implementing increased coordination with FWS for the protection of polar bears.

Lessees are advised to consult with FWS and local Native communities while planning their activities and before submission of their Oil-Spill Response Plans (OSRP) to ensure potential threats to polar bears are adequately addressed based on the most current knowledge regarding their habitat use, distribution, and population status, and to ensure adequate geographic coverage and protection are provided under the OSRP. Coastal aggregations of polar bears during the open water/broken ice period are particularly vulnerable to the effects of an oil spill, which lessees must address in their OSRP's. For example, well known polar bear aggregations have occurred at Point Barrow in close proximity to subsistence-harvested whale carcass remains. Measures to ensure adequate timely geographic coverage and protection of polar bears may include, but are not limited to, the pre-staging of oil-spill equipment at or near locations of polar bear aggregation to support oil-spill-response operations. Lessees are encouraged to consult and coordinate with FWS, local Native communities, and the Nanuk Commission to develop plans and mitigation strategies in their OSRP to prevent adverse effects to known bear aggregations. Making subsistence-harvested whale carcasses unavailable to polar bears on land during the fall open-water period may reduce polar bear aggregations and thus lower the potential for an oil spill to impact polar bears.

As part of the MMS review of proposed activities and mitigation measures, the Regional Supervisor, Field Operations (RS/FO) will notify FWS of the review of proposed Exploration Plans and Development and Production Plans (and associated OSRP) and make copies of these documents available to FWS for review and comment.

Lessees are encouraged to continue existing or initiate new training programs for oil-spill-response teams in local villages to facilitate local participation in spill response and cleanup. This effort allows local Native communities to use their knowledge about sea ice and the environment in the response process and can enhance their ability to provide protection to key resources, including polar bears.

Under the Marine Mammal Protection Act (MMPA), the incidental take of marine mammals is prohibited unless authorization is obtained by those proposing the activity, whether or not the marine mammals are endangered or threatened. To protect polar bears and other marine mammals, MMS encourages OCS operators to obtain an incidental take authorization (ITA) from FWS under the MMPA prior to any operation. Incidental takes of polar bears are allowed only if an ITA is obtained from the FWS pursuant to the regulations in effect at the time. Obtaining an ITA will ensure that lessees' operations are planned and conducted with the most current knowledge of polar bears' habitat use, distribution, and population status. The FWS must be in receipt of a petition for incidental take prior to initiating the regulatory process. An ITA must be requested annually.

Lessees are advised that polar bears may be present in the area of operations, particularly during the solid-ice period. Lessees should conduct their activities in a way that will limit potential encounters and interaction between lease operations and polar bears. Lessees are advised to contact FWS regarding proposed operations and actions that might be taken to minimize interactions with polar bears. Lessees also are advised to consult OCS Study MMS 93-0008, *Guidelines for Oil and Gas Operations in Polar Bear Habitats*.

Lessees are reminded of the provisions of the 30 CFR 250.300 regulations, which prohibit unauthorized discharges of pollutants into offshore waters. Trash, waste, or other debris that might attract polar bears or

might be harmful to polar bears should be properly stored and disposed of to minimize attraction of, or encounters with, polar bears.

No. 15 – Possible listing of Polar Bear under ESA. Lessees are advised that the U.S. Fish and Wildlife Service is proposing to list the polar bear (*Ursus maritimus*) as a threatened species under the Endangered Species Act and has initiated a comprehensive scientific review to assess the current status and future of the species. During 2007, the FWS will gather more information, undertaking additional analyses, and assessing the reliability of relevant scientific models before making final decision whether to list the species. Please refer to <http://alaska.fws.gov/fisheries/mmm/polarbears/issues.htm> for additional information. If the polar bears are ultimately listed under the ESA, then MMS will consult with FWS under Section 7 of the ESA, and may be required to apply additional mitigation measures on OCS activities to ensure appropriate protection.

No. 16 – Archaeological and Geological Hazards Reports and Surveys. The regulations at 30 CFR 250.214(e) and 30 CFR 250.244(e) require a shallow hazards report be included with all Exploration Plans (EP's) or Development and production Plans (DPP's) at the time they are submitted to MMS for completeness review. In addition, the Regional Director may require lessees to include an archaeological resources report as required by 30 CFR 250.227(b)(6) and 30 CFR 250.261(b)(6) with any EP or DPP submitted to MMS for completeness review. Lessees are encouraged to combine surveys whenever feasible.

Potential submerged archaeological resources range from historic to prehistoric. Historic resources include manmade objects or structures older than 50 years, such as shipwrecks, abandoned relics of historic importance, or submerged airplanes. The likelihood of historic resources is determined by historical records, and their areas are tentatively identified in the Alaska Shipwreck Database. There may be other occurrences of historic resources, and these will be determined during survey work. The following is a list of specific blocks in the Chukchi Sea Planning Area that may contain historic archaeological resources for which an archaeological report will be required:

- OPD NR 03-04, Solivik Island, Blocks: 6623, 6624, 6673, 6674, 6723, and 6724
- OPD NR 03-07, Point Hope, Blocks: 6609, 6610, 6611, 6659, 6660, 6661, 6709, 6710, and 6711
- OPD NR 04-01, Hanna Shoal, Blocks: 6918, 6919, 6920, 6968, 6969, 6970, 7018, 7019, and 7020
- OPD NR 04-02, Barrow, Blocks: 6566, 6567, 6568, 6616, 6617, 6619, 6666, 6667, 6668, 6716, 6717, 6801, 6802, 6803, 6851, 6852, 6853, 6901, 6902, 6903, 7102, 7103, and 7104
- OPD NR 04-03, Wainwright, Blocks: 6601, 6602, 6603, 6651, 6652, 6653, 6019, 6020, 6021, 6069, 6070, 6071, 6119, 6120, and 6121
- OPD NR 04-04, Meade River, Blocks: 6002, 6003, 6004, 6053, and 6054

Prehistoric archaeological resources may occur in areas that were sub-aerially exposed during the low stand of sea level approximately 13,000 years before present (generally 60 meters below sea level on the Alaska OCS), which would include most of the Sale 193 area. Relict terrestrial landforms such as preserved levees or terraces associated with paleo-river channels, river confluences, ponds, lakes, lagoons, or paleo-shorelines are areas where archaeological sites are most likely to occur. No prehistoric resources are expected in some areas of the shelf in water depths less than 60 meters, where: (1) there are no Quaternary sediments, and (2) where extensive ice gouging has reworked the Quaternary section, but these are not well defined and will have to be determined on a case-by-case basis.

Activities that have the potential to disturb offshore archaeological resources include: (1) anchoring; (2) pipeline trenching; (3) excavating well cellars; (4) emplacement of bottom-founded platforms; and (5) use of bottom cables for seismic data collection. Guidelines for conducting archaeological surveys are described in Notice to Lessees (NTL) 05-A03, dated July 25, 2005.

Except as approved on a case-by-case basis, 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: collecting required data, obtaining any necessary permits and

coastal consistency certification, and initiating operations including mobilizing and setting down of the facility at location. Lessees are encouraged to plan accordingly.

No. 17 – Response Plans for Facilities Located Seaward of the Coast Line. The regulations at 30 CFR 254 Subpart D implement the facility response planning provision of the Oil Pollution Act. The rule allows one plan to be used to cover multiple offshore facilities. This allows operators to reduce the cost of spill response compliance without sacrificing environmental protection.

No. 18 – Oil Spill Financial Responsibility (OSFR) for Offshore Facilities. Bidders should note that MMS has implemented regulations regarding the financial responsibility provision of the OPA. The regulations, which appear at 30 CFR 250 and 253, require those responsible for offshore oil facilities to demonstrate that they can pay for cleanup and damages caused by facility oil spills. See also 30 CFR 254.

The OSFR for offshore facilities established requirements on responsible parties for demonstrating financial responsibility for cleanup and damages caused by oil or condensate discharges from offshore oil and gas exploration and production facilities and associated pipelines. The regulations at 30 CFR 250 and 253 apply to the OCS, and state waters seaward of the line of ordinary low water along that portion of the coast that is in direct contact with the open sea, and certain coastal inland waters.

The OSFR requirements may not affect facilities which have a worst case oil spill discharge potential of 1,000 barrels or less. The regulation explains how to calculate this discharge. If the facility's potential worst case spill exceeds this amount, facilities will be required to establish and maintain OSFR at a minimum level of \$35 million. Prior to receiving approval of an application to drill or approval of an applicable lease assignment, a company must demonstrate sufficient coverage for all covered facilities which have a worst case oil spill of greater than 1,000 barrels.

The MMS Notice to Lessees No. 99-NO1 (“Guidelines for Oil Spill Financial Responsibility for Covered Facilities”), issued on and effective January 6, 1999 provides guidelines for implementing this program.

No. 19 – Good Neighbor Policy. Potential impact from a major oil spill on resources and subsistence hunting activities has been a major concern to the North Slope Borough (NSB), the Alaska Eskimo Whaling Commission (AEWC), and native tribal governments. Under the Oil Pollution Act of 1990 (OPA-90), oil and gas companies are responsible for damages from an oil spill resulting from their operations, including damages to subsistence resources. However, the above-mentioned organizations have concerns about the OPA-90 process and the remedies available to prevent disruption to seasonal subsistence activities.

The NSB and the AEWC have estimated the monetary impact of a major oil spill over a given time. They considered direct and indirect impacts, such as relocation of whaling crews and equipment, hauling of harvested meat, and socio-cultural counseling. While the long term reimbursement of the monetary impacts of a spill are covered under OPA-90, the NSB and AEWC believe that a prudent operator should provide some type of compensation commitment that could be accessed immediately.

To provide such an “insurance policy”, several oil and gas companies operating in the Beaufort Sea have elected to enter into a Good Neighbor Policy (GNP) with the NSB and AEWC; lessees are encouraged to negotiate a similar GNP for the Chukchi Sea. The GNP serves the purpose of demonstrating an operator’s commitment to a more immediate compensation system to minimize disruption to subsistence activities and provides resources to relocate subsistence hunters to alternate hunting areas or to provide temporary food supplies if a spill affects the taking of marine subsistence resources. The GNP demonstrates that the participating operators have made these commitments prior to conducting the proposed exploration or development operations. The GNP represents a viable mechanism for companies to assure timely and direct compensation to affected communities in the event of a major oil spill as required by OPA-90 and for expediting claims in accordance with 30 CFR 253 Subpart F.

No. 20 – Rentals/Minimum Royalties and Royalty Suspension Provisions.

The timing of when rental versus minimum royalty is due has been recently revised. The revised requirement is contained in the proposed Notice of Sale. For all leases issued as a result of this sale, an

Addendum will be added to the lease to modify sections 4, 5 and 6 of the lease instrument to implement these revised rental/minimum royalty requirements and to address royalty suspension provisions.

No. 21 – MMS Inspection and Enforcement of Certain Coast Guard Regulations. On February 7, 2002, the USCG published a final rule (67 FR 5912) authorizing "...the Minerals Management Service (MMS) to perform inspection on fixed OCS facilities engaged in OCS activities and to enforce Coast Guard regulations applicable to those facilities in 33 CFR Chapter I, Subchapter N." Questions regarding this authorization may be directed to the USCG as indicated in the final rule.

No. 22 – Statement Regarding Certain Geophysical Data. Pursuant to section 18 and 26 of the OCS Lands Act, as amended, and the regulations issued there under, MMS has a right of access to geophysical data and information obtained or developed as a result of operations on the OCS. A rule specifying the details and procedures regarding this right of access is found at 30 CFR 251.12. Reimbursement for the cost of reproducing these data will be made in accordance with 30 CFR 251.13.

No. 23 – Affirmative Action Requirements. Lessees are advised that they must adhere to the rules of the Department of Labor, Office of Federal Contract Compliance, at 41 CFR Chapter 60. Companies with questions regarding those rules should contact one of the various regional Department of Labor, Offices of Federal Contract Compliance.

No. 24 – Bonding Requirements. The MMS general bonding requirements are found at 30 CFR 256 Subpart I. Section 30 CFR 256.58, "Termination of the period of liability and cancellation of a bond" defines the terms and conditions under which MMS will terminate the period of liability of a bond or cancel a bond. The MMS Notice to Lessees No. 2003-N06 is an updated summary of the procedures that will be used in assessing the financial strength of OCS lessees as they implement the requirement to submit a supplemental bond in compliance with 30 CFR 256. These procedures apply to all OCS Regions.

II.B.4. Mitigation Measures for Seismic Operations in the Chukchi Sea.

The following stipulations are standard for MMS-permitted geological and geophysical (G&G) activities and would be included for all seismic activities considered under this EIS. On-lease, ancillary seismic activities would use a selected suite of these mitigation measures that are appropriate for the specific operation:

1. No solid or liquid explosives shall be used without specific approval.
2. Operations shall be conducted in a manner to ensure that they will not cause pollution, cause undue harm to aquatic life, create hazardous or unsafe conditions, or unreasonably interfere with other uses of the area. Any difficulty encountered with other uses of the area or any conditions that cause undue harm to aquatic life, pollution, or could create a hazardous or unsafe condition as a result of the operations under this permit shall be reported to the Regional Supervisor/Resource Evaluation. Serious or emergency conditions shall be reported without delay.
3. Operators must maintain a minimum spacing of 15 miles between the seismic-source vessels for separate simultaneous operations. The MMS must be notified by means of the weekly report whenever a shut down of operations occurs in order to maintain this minimum spacing.
4. Permit applicants shall use the lowest sound levels feasible to accomplish their data-collection needs.
5. Vessels and aircraft should avoid concentrations or groups of whales. Operators should, at all times, conduct their activities at a maximum distance from such concentrations of whales. Under no circumstances, other than an emergency, should aircraft be operated at an altitude lower than 1,000 feet when within 500 lateral yards of groups of whales. Helicopters may not hover or circle above such areas or within 500 lateral yards of such areas.
6. When weather conditions do not allow a 1,000-foot flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 1,000-foot altitude stipulated above. However, when aircraft are operated at altitudes below 1,000 feet because of weather conditions, the operator must avoid known whale-concentration areas and should take precautions to avoid flying directly over or within 500 yards of groups of whales.

7. When a vessel is operated near a concentration of whales, the operator must take every precaution to avoid harassment of these animals. Therefore, vessels should reduce speed when within 300 yards of whales and those vessels capable of steering around such groups should do so. Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group.
8. Vessel operators should avoid multiple changes in direction and speed when within 300 yards of whales. In addition, operators should check the waters immediately adjacent to a vessel to ensure that no whales will be injured when the vessel's propellers (or screws) are engaged.
9. Small boats should not be operated at such a speed as to make collisions with whales likely. When weather conditions require, such as when visibility drops, vessels should adjust speed accordingly to avoid the likelihood of injury to whales.
10. When any Permittee becomes aware of the potentially harassing effects of operations on endangered whales, or when any Permittee is unsure of the best course of action to avoid harassment of endangered whales (other than those effects authorized by NMFS under the MMPA and ESA), every measure to avoid further harassment should be taken until the NMFS is consulted for instructions or directions. However, human safety will take precedence at all times over the guidelines and distances recommended herein for the avoidance of disturbance and harassment of endangered whales.

II.B.4.a. Measures to Mitigate Seismic-Surveying Effects.

The measures outlined below are based on the protective measures in MMS' most recent marine seismic-survey exploration permits and the MMS' Biological Evaluation for ESA Section 7 consultation with NMFS on Arctic Region OCS activities dated March 3, 2006 (USDOJ, MMS, 2006b), recent Section 7 consultations with the USFWS regarding threatened eiders, and the recently completed *Programmatic Environmental Assessment of Arctic Ocean Outer Continental Shelf Seismic Surveys – 2006* (USDOJ, MMS, 2006a). The protective measures (e.g., ramp up) also are accepted by the scientific community and the resource agencies (e.g., NMFS and FWS). Although not empirically proven, anecdotal evidence on the displacement of marine mammals by sounds (e.g., those sounds generated by ramp up) and professional reasoning indicate that they are reasonable mitigation measures to implement.

1. Exclusion Zone – A 180/190-decibel (dB) isopleth-exclusion zone (also called a shutdown zone) from the seismic-survey-sound source shall be free of marine mammals before the survey can begin and must remain free of mammals during the survey. The purpose of the exclusion zone is to protect marine mammals from Level A harassment (injury/harm). The 180-dB (Level A harassment-injury) applies to cetaceans and the Pacific walrus, and the 190-dB (Level A harassment-injury) applies to pinnipeds other than the Pacific walrus.
2. Monitoring of the Exclusion Zone – Individuals (marine mammal biologists or trained observers) shall monitor the area around the survey for the presence of marine mammals to maintain a marine mammal-free exclusion zone and monitor for avoidance or take behaviors. Visual observers monitor the exclusion zone to ensure that marine mammals do not enter the exclusion zone for at least 30 minutes prior to ramp up, during the conduct of the survey, or before resuming seismic-survey work after shut down. The NMFS will set specific requirements for the monitoring programs and observers.
3. Shut Down – The survey shall be suspended until the exclusion zone is free of marine mammals. All observers shall have the authority to, and will, instruct the vessel operators to immediately stop or de-energize the airgun array whenever a marine mammal is seen within the exclusion zone. If the airgun array is completely powered down for any reason during nighttime or poor sighting conditions, it shall not be re-energized until daylight or whenever sighting conditions allow for the exclusion zone to be effectively monitored from the source vessel and/or through other passive acoustic, aerial, or vessel-based monitoring.
4. Ramp Up – Ramp up is the gradual introduction of sound to deter marine mammals (and other fish and wildlife) from potentially damaging sound intensities and from approaching the exclusion zone. This technique involves the gradual increase (usually 5-6 dB per 5-minute increment) in emitted sound levels, beginning with firing a single airgun and gradually adding airguns over a period of at least 20-40 minutes, until the desired operating level of the full array is obtained. Ramp-up procedures may begin after observers ensure the absence of marine mammals for at least 30 minutes. Ramp-up procedures shall not be initiated at night or when monitoring the exclusion

- zone is not possible. A single airgun operating at a minimum source level can be maintained for routine activities, such as making a turn between line transects, for maintenance needs or during periods of impaired visibility (e.g., darkness, fog, high sea states), and does not require a 30-minute clearance of the exclusion zone before the airgun array is again ramped up to full output.
5. Field Verification – Before conducting the survey, the operator shall verify the radii of the exclusion zones within real-time conditions in the field. This provides for more accurate exclusion-zone radii rather than relying on modeling techniques before entering the field. Field-verification techniques must be consistent with NMFS-approved guidelines and procedures. When moving a seismic-survey operation into a new area, the operator shall verify the new radii of the exclusion zones by applying a sound-propagation series.
 6. Monitoring of the Seismic-Survey Area – Aerial-monitoring surveys or an equivalent monitoring program acceptable to the NMFS may be required.
 7. Reporting Requirements – Reporting requirements, such as the monitoring plans required by FWS for polar bears and walrus prior to the start of seismic activities, provide the regulating agencies with specific information on the monitoring techniques to be implemented and how any observed impacts to marine mammals will be recorded. In addition, operators must report immediately any shut downs due to a marine mammal entering the exclusion zones and provide the regulating agencies with information on the frequency of occurrence and the types and behaviors of marine mammals (if possible to ascertain) entering the exclusion zones.
All bird collisions (with vessels or aircraft) shall be documented and reported within 3 days to MMS. Minimum information will include species, date/time, location, weather and, if a vessel is involved, its operational status when the strike occurred. Bird photographs are not required, but would be helpful in verifying species. Operators are advised that the FWS does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.
 8. Temporal/Spatial/Operational Restrictions – Dynamic management approaches to avoid or minimize exposure, such as temporal or spatial limitations are based on marine mammals or birds being present in a particular place or time, or being engaged in a particularly sensitive behavior (such as feeding).
 - Seismic surveys must not occur in the Chukchi Sea spring lead system before July 1 of each year, unless authorized by NMFS, to provide bowhead cow/calf pairs additional protection. Operators are required to provide information regarding their operations within the spring lead system upon request of MMS. The MMS may request information regarding number of vessels and their dates/points of entry into and exit from the spring lead system.
 - No seismic vessel activity, including resupply vessels and other related traffic, will be permitted within the Ledyard Bay Critical Habitat Area after July 1 of each year, unless human health or safety dictates otherwise. Incursions for human health or safety purposes shall be reported within 24 hours to MMS. Other incursions will be considered noncompliance with this condition.
 - Survey-support aircraft will avoid flying over the Ledyard Bay Critical Habitat Area below an altitude of 1,500 feet (450 meters) after July 1 of each year, unless human health or safety dictates otherwise. Incursions for human health or safety purposes shall be reported within 24 hours to MMS. Other incursions will be considered noncompliance with this condition. In other coastal areas, seismic-survey-support aircraft should maintain at least 1,500 ft (450 m) over beaches, lagoons, and nearshore waters as much as possible.
 - Seismic-survey and support vessels will minimize operations that require high-intensity work lights, especially within the 20-m bathymetric contour. High-intensity lights will be turned off in inclement weather when a vessel is not actively participating in seismic surveys; however, navigation lights, deck lights, and interior lights could remain on for safety.

II.B.4.b. Alternative Mitigation for Seismic Surveying.

The activities analyzed in the final seismic PEA (USDOJ, MMS, 2006a) included conducting marine-streamer 3D and 2D seismic surveys, high-resolution site-clearance seismic surveys, and ocean-bottom-cable seismic surveys. The PEA's cumulative activities scenario and cumulative impact analysis focused on oil- and gas-related and non-oil and gas-related noise-generating events/activities in both Federal and State of Alaska waters that were likely and foreseeable. Other appropriate factors, such as arctic warming, military activities, and noise contributions from community and commercial activities, also were considered.

The following mitigation alternatives related to conducting seismic surveys were analyzed as part of the PEA:

Seismic Survey Mitigation Alternative 1. No seismic-survey permits issued for geophysical exploration activities (No Action). *(Referenced in the PEA as Alternative 1)*

Seismic Survey Mitigation Alternative 2. Seismic surveys for geophysical-exploration activities would be permitted with existing Alaska OCS G&G exploration stipulations and guidelines. *(Referenced in the PEA as Alternative 2)*

Seismic Survey Mitigation Alternative 3. Seismic surveys for geophysical exploration activities would be permitted incorporating existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine mammals, including a 120-decibel-(dB)-specified safety zone. *(Referenced in the PEA as Alternative 3)*

Seismic Survey Mitigation Alternative 4. Seismic surveys for geophysical-exploration activities would be permitted incorporating existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine mammals, including a 160-dB-specified safety zone. *(Referenced in the PEA as Alternative 4)*

Seismic Survey Mitigation Alternative 5. Seismic surveys for geophysical-exploration activities would be permitted incorporating existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine mammals, including 160-dB- and 120-dB-specified safety zones. *(Referenced in the PEA as Alternative 5)*

Seismic Survey Mitigation Alternative 6. Seismic surveys for geophysical-exploration activities would be permitted incorporating existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine mammals, including a 180/190-dB-specified exclusion zone. *(Referenced in the PEA as Alternative 6)*

Summaries of the potential impacts of Alternatives 1, 3, 4, 5, and 6 from the PEA analyses are provided in Appendix D. Alternative 2 was dropped from detailed analysis in the PEA because of its potential to cause unavoidable significant impacts. See the PEA for a more detailed and thorough description and discussion of the potential impacts of conducting seismic surveys and the mitigation measures proposed to protect the biological resources of the Arctic Ocean.

Based on analyses in the PEA of the potential impacts associated with the alternatives and review of comments received from the public and agencies, MMS and NMFS selected to implement Alternative 6. The Selected Alternative and the incorporated mitigation measures fulfill MMS' statutory mission and responsibilities and the stated purpose and need for the Proposed Action (to issue geophysical exploration permits for seismic surveys that are technically safe and environmentally sound) while considering environmental, technical, and economic factors. By incorporating mitigation measures into the Selected Alternative and designating them as permit stipulations and/or conditions of approval, MMS determined that no significant adverse effects (40 CFR 1508.27) on the quality of the human environment would occur from the Selected Alternative. Therefore, MMS found that an environmental impact statement was not required and issued a Finding of No Significant Impact (FONSI).

In consideration of the level of uncertainty in some resource areas and erring on the side of being protective of the resources, MMS developed additional mitigation and monitoring measures to further reduce the level of any potential adverse effects. These measures were incorporated into the Selected Alternative in addition to the measures that defines Alternative 6, providing additional protection of the resources and another level of proactive management.

The Selected Alternative (Alternative 6) and the associated suite of mitigation measures are used in the scenario and analysis in this Chukchi Sea Sale 193 EIS. The alternatives considered in the PEA are alternatives to the suite of mitigation measures for seismic surveying assumed for analysis in this EIS.

Depending on the environmental issues and analysis associated with an individual seismic survey or with multiple seismic surveys in the Chukchi Sea Planning Area, some of the mitigations measures described below may be selectively incorporated in Incidental Take Authorizations issued by either NMFS or FWS under section 7 of the ESA or LOA's/IHA's issued under the MMPA for activities under Geological and Geophysical exploration permits issued by MMS. These mitigation measures would function to provide further protection from the possibility for causing adverse environmental impacts in special situations. Any mitigation measures addressing impacts to marine mammals and threatened and endangered species identified in Marine Mammal Protection Act-related incidental take authorizations and/or Endangered Species Act-related reasonable and prudent alternatives would supersede any such related mitigation measures in the relevant MMS permit.

1. A 120-dB aerial monitoring zone for bowhead whales in the Chukchi Sea will be established and monitored: (1) once four or more migrating bowhead whale cow/calf pairs are observed at the surface during the vessel research-monitoring program; (2) once Barrow whalers notify NMFS or MMS that bowhead whale cow/calf pairs are passing Barrow; or (3) on September 25, whichever is earliest. Once notified by NMFS or MMS, a daily aerial survey will occur (weather permitting) within the area to be seismically surveyed during the next 24 hours. Whenever four or more migrating bowhead whale cow/calf pairs are observed at the surface during an aerial monitoring program, no seismic surveying shall occur within the 120-dB safety zone around the area where the whales were observed by aircraft, until two consecutive surveys (aerial or vessel) indicate they are no longer present within the 120-dB safety zone of seismic-surveying operations.
2. A 160-dB vessel monitoring zone for bowhead and gray whales will be established and monitored in the Chukchi Sea during all seismic surveys. Whenever an aggregation of bowhead whales or gray whales (12 or more whales of any age/sex class that appear to be engaged in a nonmigratory, significant biological behavior [e.g., feeding, socializing]) are observed during an aerial or vessel monitoring program within the 160-dB safety zone around the seismic activity the seismic operation will not commence or will shut down immediately, until two consecutive surveys (aerial or vessel) indicate they are no longer present within the 160-dB safety zone of seismic-surveying operations.
3. Dedicated aerial and/or vessel surveys, if determined by NMFS to be appropriate and necessary, shall be conducted in the Chukchi Sea during the fall bowhead whale-migration period to detect bowhead whale cow/calf pairs and to detect aggregations of feeding bowhead and gray whales. The protocols for these aerial and vessel monitoring programs will be specified in the MMPA authorizations granted by NMFS.
4. Survey information, especially information about bowhead whale cow/calf pairs or feeding bowhead or gray whales, shall be provided to NMFS as required in ITA's, and will form the basis for NMFS determining whether additional mitigation measures, if any, will be required over a given time period.
5. Potential impacts to female walrus and dependent calves are a major concern. Vessels and aircraft should avoid concentrations or groups of walrus. Operators should, at all times, conduct their activities at a maximum distance from such aggregations. Seismic-survey and associated support vessels shall observe a 0.5-mile (~800-meter) safety radius around Pacific walrus groups hauled out onto land or ice.
6. Potential impacts to female walrus and dependent calves are a major concern. Vessels and aircraft should avoid concentrations or groups of walrus. Operators should, at all times, conduct their activities at a maximum distance from such aggregations. Under no circumstances, other than an emergency, should aircraft be operated at an altitude lower than 1,500 feet when within 0.5-mile (800 meters) of walrus groups. Helicopters may not hover or circle above such areas or within 800 lateral meters of such areas.
7. Seismic-survey operators shall notify MMS in the event of any loss of cable, streamer, or other equipment that could pose a danger to marine mammals or other wildlife.
8. To avoid significant additive and synergistic effects from simultaneous seismic-survey operations that might hinder the migration of bowhead whales, NMFS and MMS will review the seismic-survey plans and may require special restrictions, such as additional temporal or spatial separations.
9. Seismic cables and airgun arrays must not be towed in the vicinity of fragile biocenoses, unless MMS determines the proposed operations can be conducted without damage to the fragile biocenoses. Seismic-survey and support vessels shall not anchor in the vicinity of fragile

biocenoses (e.g., kelp beds) as identified by MMS or may be discovered by the operator during the course of their operations, unless there is an emergency situation involving human safety and there are no other feasible sites in which to anchor at the time. Permittees must report to MMS any damage to fragile biocenoses as a result of their operations.

II.B.5. Issues.

II.B.5.a. Issues Analyzed in this Environmental Impact Statement.

The major issues that frame the environmental analyses in this EIS are the result of concerns raised during years of scoping for the Alaska OCS lease sale EIS's including recent scoping meetings in the Chukchi Sea Communities. Other criteria used to identify issues include the following: issues identified in the CEQ regulations; issues identified by MMS; comments on a draft EIS; or new information. The following issues relate to potential impact-producing factors (IPF's) and the resources and activities that could be affected by OCS exploration, development, production, and transportation activities.

II.B.5.a(1) Oil Spills. The most frequent concerns were over the potential impact of oil spills on the marine and coastal environment. Specific concern was raised regarding the potential effects of oil spills on marine mammals, subsistence hunting, water quality, and threatened and endangered species. Of particular concern are endangered bowhead whales and threatened spectacled eiders. Other concerns were fate and behavior of oil spills, availability and adequacy of oil-spill-containment, oil spill cleanup technologies and strategies, impacts of cleanup methods, effects of winds and currents, weathering, toxicological effects of fresh and weathered oil, and ability to effectively clean up oil spills in broken-ice conditions.

II.B.5.a(2) Subsistence. Commenters clearly voiced their concerns that leasing activities represent a "trampling" of the Natives' subsistence rights. While many subsistence species are of concern, one of the greatest overall concerns was the potential impacts on the bowhead whale and subsistence whaling. Commenters further stated that all subsistence species should be closely surveyed and monitored to establish a baseline to better measure the possible impacts. Of particular concern is the potential for onshore pipelines and other infrastructure associated with offshore Chukchi Sea development to impact the Western Arctic (caribou) Herd and subsistence use of the herd. Commenters clearly stated that MMS should adopt the standard in the MMPA, i.e., no unmitigable adverse impact on the availability of a species or stock for taking for subsistence uses. Commenters voiced that whenever the potential exists for the take of a subsistence resource to fall below the level required to meet subsistence need for a season, the effects must be considered significant.

Commenters expressed concern over changing conditions associated with climatic changes. Greenland and Canadian Inuit people are reporting changing climatic conditions are limiting their ability to hunt and access the traditional hunting grounds. Canadian Inuit people stated that the arctic ice pack is melting fast, and each year the ice pack leaves the area and does not return as it did in the past. People are traveling longer distances to harvest marine mammals. Fewer walrus are being harvested because of retreating ice, creating a difficult situation.

II.B.5.a(3) Bowhead Whale. Commenters expressed concerns over the impacts that oil and gas activities would have on the bowhead whale and their migration patterns. Of particular concern was the noise associated with oil and gas activity and how the bowhead may not be able to be harvested as a result of changes in the migratory routes of the bowhead. Oil spill impacts to the bowheads' ecology, as well as direct and indirect impact subsistence hunting, are of concern.

II.B.5.a(4) Nonendangered Marine Mammals. Commenters noted that the potential for exploration and development activities to occur and cause impacts within any area known to be critical to the success of the subsistence harvest of bowhead and beluga whales, Pacific walrus, seals, polar bears, and other marine mammal resources is of central concern of the Chukchi Sea communities. Commenters expressed grave concern over the possibility of a changing climate causing problems for marine mammal species. Commenters again noted the importance of protecting the arctic ecosystem and recognizing that this environment is all part of the food web. Commenters noted changes in the environment already are impacting various marine mammal species, and impacts from oil and gas activities would be additive and make life for the Chukchi Sea communities even more difficult.

II.B.5.a(5) Water Quality Degradation. Issues related to water quality degradation included OCS operational discharges of drilling muds and cuttings, produced waters, domestic wastes, sediment disturbance, oil spills and blowouts, and discharges from service vessels.

II.B.5.a(6) Structure and Pipeline Placement. Some of the concerns expressed related to structure and pipeline emplacement, lighting issues with platforms, bottom area disturbances from bottom-founded structures or anchoring, and construction of onshore infrastructure.

II.B.5.a(7) OCS-Related Support Services, Activities, and Infrastructure. Concerns were expressed over the activities related to the support of OCS operations, including vessel and helicopter traffic and emissions, and seismic-surveying activities.

II.B.5.a(8) Sociocultural and Socioeconomic. Commenters noted that the level of activity near North Slope communities is contributing to the sense that the communities are being surrounded. Commenters also verbalized the notable changes in climate and that these changes are outside of the bounds of traditional knowledge. Concerns also include impacts on employment, population fluctuations, and cultural impacts.

II.B.5.a(9) Coastal Zone Management. Concern has been expressed over potential conflicts with the State of Alaska's Coastal Zone Management Program and with the NSB's land use plans.

II.B.5.a(10) Other Issues. Other concerns and issues related to OCS operations have been identified. Several of these issues are subsets or variations of the issues listed above. All are taken under advisement and are considered in the analyses, if appropriate.

II.B.5.a(11) Resource Topics Analyzed in the EIS. The analyses in Section IV address the issues and concerns identified above under the following resource topics:

- Water Quality
- Air Quality
- Lower-Trophic-Level Organisms
- Fish Resources
- Essential Fish Habitat
- Threatened and Endangered 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 Programs
- Environmental Justice

II.B.5.b. Issues Considered But Not Analyzed.

All comments received in response to the Call for Information and Notice of Intent to Prepare an EIS, and those received during public scoping meetings, are part of the record of information used in developing the EIS, and are available to the decisionmakers during the deliberation process. The MMS has considered and "scoped out" the issues below for detailed analysis in this EIS. Several issues raised in scoping will not be considered for detailed study in the EIS, because they are out of the scope of this EIS or inherently do not affect the environmental analyses. These issues include administrative, policy, or process issues.

- *Arctic Research Policy Act of 1983 (P.L. 183), Section II.B, provides a definition of the “Arctic.” Alaska State government only has power below the Yukon River. The Native Village of Barrow is the authority in the Arctic area:* This issue is beyond the scope of this EIS.
- *Native Villages do not recognize the power of the Alaska Native Claims Settlement Act corporations:* This issue is beyond the scope of this EIS.
- *The Alaska State Constitution gave ownership of the North Slope to the Natives:* This issue is beyond the scope of this EIS.
- *The Bureau of Indian Affairs recognized a 100-mi radius around the village as a subsistence-use area:* There could be many lawsuits on whether or not this extends to the OCS.
- *OCS revenue sharing is necessary to help compensate for restrictions on access to traditional subsistence-harvest areas, deflection of resources out of those areas that can be accessed, increased air pollution, creation of navigational hazards, and monumental demands on the time of community officials and individuals compelled to participate in the planning processes associated with a never-ending succession of lease-sale and project proposals:* This issue is beyond the scope of this EIS. Only the Congress can appropriate funds for impact assistance. In 2005, Congress established a Coastal Impact Assistance Program (CIAP) via the Energy Policy Act. The MMS is in the process of developing regulations to implement that program. Information on the CIAP can be found on the MMS website at <http://www.mms.gov/offshore/CIAPmain.htm>.
- *Impact funds are needed by the communities to respond to effects of expansion of oil and gas activities. Currently, revenues do not go to the Tribal governments. Leasing is the biggest land steal:* This issue is beyond the scope of this EIS. Only the Congress can appropriate funds for impact assistance. In 2005, Congress established a Coastal Impact Assistance Program (CIAP) via the Energy Policy Act. The MMS is in the process of developing regulations to implement that program. Information on the CIAP can be found on the MMS website at <http://www.mms.gov/offshore/CIAPmain.htm>.
- *The conflict avoidance stipulation should be incorporated into regulations. Stipulations are, by nature, impermanent. The MMS’ confidence in this stipulation to smooth relations between subsistence marine mammal hunters and industrial operators should be reflected in formal agency rules:* The MMS rules already include such a provision. 30 CFR 250.202 states that OCS plans must demonstrate that proposed activities will not unreasonably interfere with other uses of the OCS.
- *Aquatic Invasive Species.* The introduction of aquatic invasive species (AIS) into a marine ecosystem can result in adverse impacts. Such introductions occur when species establish self-sustaining populations beyond their historical geographic ranges. Potential vectors for introducing AIS are ballast-water discharge, hull fouling, and equipment placed overboard (e.g., anchors, seismic airguns, hydrophone arrays, ocean-bottom-survey cables). The U.S. Coast Guard (USCG) developed regulations (33 CFR 151) that implements provisions of the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (16 U.S.C. 4701-4751) as amended by the National Invasive Species Act of 1996 (NISA). The NISA required the development of national guidelines to prevent the introduction and spread of nonindigenous species into U.S. waters via ballast water of commercial vessels. The regulations mandate a ballast-water-management program and reporting requirements. The rule specifically addresses all vessels equipped with ballast tanks bound for ports or places within the U.S. and/or entering U.S. waters. At this time, mid-ocean ballast-water exchange is the most practicable method to help prevent the introduction of invasive species into U.S. waters. The USCG considers any ballast-water-management plan that meets International Maritime Organization (IMO) guidelines meets the regulatory requirements of 151.2035. Vessels that conduct coastwise trade (within 200-mile Exclusive Economic Zone) are not addressed in the final 2004 regulations because they cannot conduct a mid-ocean ballast-water exchange. The USCG is examining the possibility of establishing alternative ballast-water-exchange zones. The coastwise trade vessels are still required to submit ballast water reporting forms. Vessels brought into State of Alaska or Federal waters would be subject to current USCG regulations at 33 CFR 151, which are intended to reduce the transfer of invasive species. Section 151.2035 (a)(6) requires the “removal of fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, State, and Federal regulations.” These regulations appear effective, as no AIS have been documented in the Alaskan Chukchi or Beaufort seas. Furthermore, the Chukchi and Beaufort seas pose harsh and frigid environmental conditions that are believed to impose major and difficult challenges to AIS that

might be introduced into the region's waters by vessels or equipment. Overall, the likelihood of introducing AIS from the proposed action is considered to be very low, and this issue is not considered further in this EIS.

- *Impacts to Commercial Fisheries:* Most fisheries conducted in the Alaskan portions of the Chukchi Sea are of a subsistence nature and are conducted close to shore. State-managed commercial fisheries for salmon and snow crab occur in the southern Chukchi Sea well to the south of the proposed lease sale area. No commercial fisheries exist in or near the proposed Chukchi Sea Sale 193 area.

II.C. Proposed Chukchi Sea Lease Sale.

II.C.1. Alternative I – Proposed Action.

The Proposed Action offers for lease those blocks identified in the Area ID as shown in Map 1. The Chukchi Sea Sale 193 area includes 6,156 whole or partial blocks covering approximately 34 million acres in the Chukchi Sea. The Chukchi OCS is viewed as one of the most petroleum-rich offshore provinces in the country, with geologic plays extending offshore from some of the largest oil and gas fields on Alaska's North Slope. The MMS's current petroleum assessment indicates that mean technically recoverable oil resource of 12 billion barrels (Bbbl) with a 5% chance of 29 Bbbl. Most government and industry analysts agree that this province could hold large oil fields comparable to any frontier area in the world. Thus, it is reasonable to assume that exploration of this area could lead to oil discoveries and offshore development. However, because it is a true frontier area, the pace to development will be slow. For purposes of analysis, we assume that oil and gas will be recovered as a result of a single development, which might result from the sale.

II.C.1.a. Summary of Impacts.

The following summarizes the detailed impact analyses found in Section IV.C. This summary is limited to the impact of a typical proposed action. Cumulative impacts are assessed under the cumulative analysis in Section V and are not summarized here.

The impact analysis for the typical proposed action assumes that the Standard Lease Sale Stipulations, ITL's, and Standard Seismic Survey Stipulations are in place, in addition to MMS and other Federal rules.

Water Quality. In the Proposed Action, water quality in the Chukchi Sea may be affected by discharge of pollution into the marine waters. The discharges may come from point source and non-point source discharges, which include: exploration and production drilling, deck drainage, platform discharges, construction activities (platform and/or pipeline placement and modifications), operational activities, and/or non-permitted releases and oil spills.

Discharges of muds, cuttings, and produced waters are the major waste stream associated with oil and gas exploration and drilling post-lease activities. Drilling muds are generated during drilling operations that may extend for 2-4 months for the exploration phase, and from 3-5 years during the development phase; produced waters are generated as oil and gas is pumped from the formation in the production and operation phase of post-lease activities. Other possible impacts are associated with miscellaneous discharges which include sanitary and domestic waste.

The production of formation waters over the life of the field can be estimated between 2.4 and 43 Bbbl. The exploration and development scenario supposes that production slurry (oil, gas, water) will be gathered on the central platform where gas and water will be separated and the produced water reinjected. Shallow injection wells will handle these wastewaters and treated drill cuttings. Gas recovered with oil production will be used as fuel for the facility or reinjected into the main reservoir to increase oil recovery. If formation waters were discharged into the water column rather than reinjected, the discharge would be regulated and permitted by USEPA. The effect on water quality would be local and would continue for the life of the discharge. The effect on local water quality is expected to be moderate, while the effect on regional water quality is expected to be very low. Effects on water quality from dredging (and dumping) are expected to be local and short-term. Turbidity would increase over a few square kilometers in the

immediate vicinity of dredging operations only during actual dredging. Effects on local water quality are expected to be low, while the effect on regional water quality is expected to be very low.

Sustained degradation of local and area wide water quality to levels above State and Federal criteria from hydrocarbon contamination resulting from oil and gas postlease activities is unlikely. Hydrocarbon concentrations from the one assumed oil spill equal to or greater than (\geq)1,000 bbl could exceed the chronic criterion of 0.015 parts per million (ppm) total hydrocarbons on at least several thousand square kilometers for a short period of time. Concentrations above the acute criterion are not anticipated. Effects of an oil spill on water quality are expected to be low both locally and regionally.

The effect of the Proposed Action on water quality as a result of exploration and development and production is expected to be moderate locally and low regionally.

Air Quality. Because of the distance of the proposed activities from shore, attendant atmospheric dispersion, low existing levels of onshore pollutant concentrations, and compliance with Federal and State of Alaska air quality requirements, the ambient concentrations of pollutants at most locations may be assumed to be well within National Air Quality Standards. Accordingly, we conclude the effect on air quality under the Proposed Action is low.

Lower-Trophic-Level Organisms. The disturbance effect of the 14 anticipated exploratory wells probably would be low unless the wells were located near any special biological communities; regardless, the MMS would review further any installation proposals and could require surveys. Exploratory discharges during summer probably would lead to low effects in offshore locations and to moderate effects on benthos in the nearshore portion of Alternative 1. Water circulation under the winter ice cover is slow, so we assume that produced water would be reinjected; regardless, the local effects of produced-water discharge for the life of the field probably would be moderate, and any such proposals would be reviewed in detail by MMS and possibly USEPA. We assume that an extensive system of buried pipelines would radiate from a central production platform and that a single pipeline would extend to shore. This pipeline installation probably would disturb 1,000-2,000 acres of typical benthos for less than a decade, leading to a moderate level of effect. The disturbance effects would be assessed and possibly monitored by the pipeline company, the MMS and/or the Corps of Engineers. The effects of an alternative to production pipelines—the transportation of produced oil in vessels—would pose a much greater spill risk to the coast near the Spring Lead System. The Oil-Spill-Risk Analysis (OSRA) model estimates a 40% chance of one or more large spills \geq 1,000 bbl occurring during the production life of the project, and only a 1% chance of one or more large spills occurring and contacting the Alaskan Chukchi Sea coastline within 3 days over the production life of the proposed action for Alternative I. If oil did contact this coastline, the oil probably would persist in a few of the tidal and subtidal sediments for a couple decades, leading to a moderate lower-trophic impact. The chance one or more large spills occurring and contacting the coastline increases to 6% within 30 days, demonstrating the advantages of requirements for rapid response capability. During the abandonment phase, we assume that the extensive pipeline system would be cleaned, plugged, and abandoned in place, at which time ownership would be questionable. However, bond requirements could be increased for Chukchi Sea developers, making the bond size commensurate with the estimated financial obligations associated with the careful construction and abandonment of pipelines. Overall, the level of effect on lower trophic-level organisms with standard mitigation would be moderate, and the level would be minor with proposed requirements for rapid spill response capability and for larger development bonds.

Fish Resources. A review of the available science and management literature shows that at present, there are no empirical data to document potential impacts from seismic surveys reaching a local population-level effect. The experiments conducted to date have not contained adequate controls to allow us to predict the nature of a change or that any change would occur. Thus, the information that does exist has not demonstrated that seismic surveys alone would result in significant impacts to marine fish or related issues (e.g., impacts to migration/spawning, rare species, subsistence fishing).

Periodic accidental spills of approximately 5 gallons (gal) during refueling operations during seismic surveys or potential rupturing of seismic streamers is not believed likely to result in an adverse impact to fish resources in the Chukchi Sea.

Noise-related disturbance effects to fish and direct loss or degradation of fish habitats would likely occur during construction in the marine environment (e.g., well sites, platform placement, and pipeline trenching/burial) and at freshwater sites (pipeline and maintenance road construction). Future facility locations would be evaluated on a site-specific basis to avoid or minimize adverse construction-related impacts to fish habitats that could be affected by the proposed lease sale. These construction activities are anticipated to result in temporary and/or localized adverse impacts to fish and fish habitats, but recovery would be expected to occur in fewer than three generations.

A large oil spill impacting intertidal or estuarine spawning and rearing habitats used by capelin or other fishes potentially could result in significant adverse impacts to some local breeding populations. Recovery to former status by dispersal from nearby population segments would require more than three generations. Given a lack of contemporary abundance and distribution information, large oil spill effects on rare or unique species (including potential extirpation) could occur, but would likely go unnoticed or undetected.

Depending on the timing, extent, and persistence of a large spill, some distinct runs of pink and chum salmon could be eliminated. Recovery from this significant adverse impact would only occur as strays from other populations colonized the streams after the oiled habitats recovered. These local fish stocks would not be available for subsistence harvest for many years.

Chronic small-volume spills reaching intertidal or estuarine spawning and rearing habitats used by capelin, salmon, or other fishes potentially could periodically impact local stocks that could decrease the numbers of breeding adults and/or suppress recruitment requiring less than 3 generations to recover to their former status. Chronic degradation of salmon habitats could lead to the gradual loss of distinct stocks. Recovery would not occur if degraded conditions persisted.

For the purposes of evaluating the potential impacts of a large oil spill on fish resources, oil spill response is assumed to have limited effectiveness (less than 100% of spilled oil recovered) because of the unpredictability of response time, proximity of the launch site(s) to fish-concentration areas, known limitations of the response during certain environmental conditions (such as under ice or broken-ice), and the numbers of fish that could be impacted in a short period of time (less than [$<$]36 hours).

Essential Fish Habitat. Seismic surveys conducted in association with the proposed lease sale would have minor adverse impacts on EFH. Future facility locations would be evaluated on a site-specific basis to avoid or minimize adverse construction-related impacts to EFH that could be affected by the proposed lease sale. Specific regulatory processes and required consultations would guide mitigation efforts to reduce direct construction impacts to fish-bearing streams and lakes such as clear-span crossings, setbacks, and sediment and erosion control measures. Construction-related impacts are determined to result in minor adverse impacts to freshwater and marine salmon EFH.

In the event of a large oil spill or chronic small-volume spills, effects on Pacific salmon EFH would depend primarily on the season and location of the spill; the life stage of the fishes (adult, juvenile, larval, or egg) impacted; and the duration of the exposure. A large oil spill or chronic small-volume spills impacting intertidal or estuarine spawning, rearing, and migration habitats used by early life-history stages of Pacific salmon is likely to result in significant adverse effects on local populations requiring three or more generations to recover to their former status. Impacts to these fish habitats could result in loss of discrete population stocks. These salmon stocks would recover only by colonization by strays from non-affected populations.

Threatened and Endangered Species.

Threatened and Endangered Marine Mammals. Oil and gas exploration, development, production and abandonment could result in a considerable increase in noise and disturbance in the spring, summer and autumn Arctic Ocean range of the bowhead whale from factors including, but not limited to:

- multiple 2D/3D seismic surveys in open water;
- icebreakers use;
- high resolution seismic surveys and related main vessel noise and disturbances;
- support vessel activities;

- open water exploration drilling from an ice-breaker accompanied drillship;
- helicopter flights: exploration (4/day for exploration seismic); 13/day for exploration drilling; 5/day during shore base construction; 2/day for production;
- shore base construction at Pt. Belcher;
- platform construction of 1 bottom founded platform; assembly noise and related disturbance;
- noise from production drilling and operations;
- pipeline construction; and
- abandonment.

Of primary concern is that the aforementioned activities could potentially produce sufficient noise and disturbance that bowhead whales will avoid an area of high value to them and suffer consequences of biological significance. Such areas might include: feeding or resting areas used by large numbers of individuals or by females and calves.

Uncertainty exists about the potential effects of seismic surveys on bowhead whales (especially on calf survival or growth and female reproduction) in the Chukchi Sea due to a lack of current data about their use of the Proposed Action area during periods when seismic surveys could be occurring. What is known, however, is that the observed response of bowhead whales to seismic survey noise varies among studies. Some of the variability appears to be context specific (i.e., feeding versus migrating whales) and also may be related to the whale's reproductive status and/or sex or age.

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). Recent monitoring studies (1996-1998) and traditional knowledge 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 20-30 kilometers (km), with received sound levels of 116-135 dB re 1 μ Pa (rms) (decibels re 1 microPascal [root mean-square]). Richardson (1999) reported that within 12-24 hours after seismic survey operations ended, the sighting rate within 20 km was similar to the sighting rate beyond 20 km; however, the sighting rate within 20 km was statistically lower than beyond 20 km even 96 hours after seismic survey operations. Therefore, there is concern within the subsistence whaling communities that whales exposed to this source of noise (and other sources) may become more sensitive, at least over the short term, to other noise sources.

If seismic surveys were unmitigated, or are insufficiently mitigated to reduce impacts to the whales themselves, effects that are biologically significant could result if seismic surveys cause avoidance of feeding, resting (including nursing), or calving areas by large numbers of females with calves or females over a period of many weeks. Potential impacts to the population would be related to the numbers and types of individuals that were affected (e.g., juvenile males versus females with calves).

It is unlikely that there would be any adverse effects from seismic-survey activities in the Chukchi Sea sale on fin or humpback whales because of the distance the species will be from such activities, i.e., that they are not expected to occur in the Proposed Action area. However, if humpback whales and fin whales were on occasion to enter the Proposed Action area, available data indicate that humpback whales are likely to be more responsive to seismic-survey noise than fin whales.

An increase in exploration, development, and production would result in increased aircraft (fixed-wing and helicopter) and vessel traffic in the Proposed Action area. Repeated encounters with aircraft and/or vessels that cause panicked or "fleeing" behavior could cause temporary physiological stress reactions in bowhead whales, which over time could have an adverse affect on whale health. However, occasional brief feeding interruptions by a passing vessel or aircraft will probably not cause significant adverse impacts.

Bowheads may exhibit strong temporary avoidance behavior if approached by vessels at a distance of 1-4 km (0.62-2.5 mile [mi]) and appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources. Fleeing behavior from vessel traffic generally stops within minutes after the vessel passes, but scattering may persist for a longer period. In some instances, bowhead whales do return to their original location. When icebreakers are operating with a sound-to-noise ratio of 30 dB, many bowhead whales begin to respond at a distance of 4.6-20 km (2.86-12.4 mi).

Most bowheads exhibit no obvious response to aircraft over flights at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft) some changes in whale behavior may occur, depending on the type of aircraft 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. However, depending on where shore bases, exploration activities, and production facilities are located, the effect of such aircraft-related interruptions could result in repeated interruption and increased stress to whales in the flight path. This could become biologically important if the whales in the area were feeding, resting, or nursing. This potential effect could be mitigated by ensuring that flight paths avoid whale aggregations or that flights are high enough to avoid disturbance.

Bowheads respond to drilling noise at different distances depending on the types of platform from which the drilling is occurring. Data indicate that many whales can be expected to avoid an active drillship at 10-20 km or possibly more. The long-term response of bowheads to production facilities located at the southern end of the migration corridor is unknown.

The effects of a large oil spill and subsequent exposure of the bowhead whale population to fresh crude oil would depend on how many whales contacted oil; the ages and reproductive condition of the whales contacted; the duration of contact; the amount of oil spilled; and the age/degree of weathering of the spilled oil at the time of contact. 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 spilled into leads or ice-free areas frequented by migrating bowheads, a large portion of the population could be exposed. If a large slick of fresh oil contacted a large aggregation or aggregations of feeding bowheads, especially with a high percent of calves, the effect might be expected to be greater than under more typical circumstances. Prolonged exposure to freshly spilled oil could cause adult whale mortalities, but based on available information, the number likely would be small if the spill contacted bowheads in open water. Bowhead whales would be particularly vulnerable to effects from oil spills during their spring migration because of their use of ice edges and leads, where spilled oil would tend to accumulate. Bowheads may also have heightened vulnerability to spilled oil because of the functional morphology of their baleen. If bowhead whale baleen is fouled, and if crude oil is ingested, there could be adverse effects on the feeding efficiency and food assimilation. Such effects are expected to be of most importance to calves, pregnant females, and lactating females.

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. Neither fin whales nor humpback whales are known to typically inhabit the Chukchi Sea Planning Area; however, they could be disturbed by an increase in Chukchi Sea-related oil and gas shipping through the Bering Strait. Such effects should be temporary and minor. Therefore, based on available information, it is unlikely that fin and humpback whales are to be adversely affected by noise-causing oil and gas activities in the Proposed Action area. There is uncertainty about the effects on bowheads (or any large cetacean) from the event of a large spill. If a large amount of fresh oil contacted a significant portion of such an aggregation, "effects potentially greater than typical" would be assumed, and we cannot rule out population-level effects if a large number of females and newborn or very young calves were contacted by the oil.

In its Arctic Region Biological Opinion issued under section 7 of the ESA (dated June 16, 2006), NMFS concluded that leasing and exploration are not likely to jeopardize the continued existence of the bowhead whale; however, the potential additive effects of oil and gas activities associated with exploration, production, and transportation throughout the Chukchi and Beaufort seas is of concern. In formulating their opinion, NMFS used the best information available, including information provided by MMS, recent research on the effects of oil and gas activities on the bowhead whale, and the traditional knowledge of Native hunters and the Inupiat along Alaska's North Slope. Conservation recommendations were provided to improve the understanding of the impacts of oil and gas activities on the bowhead whale, as well as to minimize or mitigate adverse effects.

Implementing existing MMS mitigation measures (Sec. II.B.2 - Mitigation Measures) – which include Standard Stipulations and Information to Lessees, as identified in Chukchi Sea Oil and Gas Lease Sale 126

(1991) and/or in Beaufort Sea Planning Area multiple-sale (2003) EIS's, and stipulations associated with the Programmatic Environmental Assessment, Arctic Ocean OCS Seismic Surveys (2006) – in concert with the conservation recommendations in the NMFS 2006 Arctic Region Biological Opinion would provide the necessary protection to prevent and/or minimize adverse environmental impacts on threatened and endangered species, namely the bowhead whale.

Threatened and Endangered Marine and Coastal Birds. Lease Sale 193 could present new sources of disturbance, collision hazards, and oil/toxic pollution that could result in the taking of threatened Steller's and spectacled eiders. Without comprehensive mitigation measures to avoid or minimize potential impacts, these activities are likely to adversely affect Steller's and spectacled eiders. Similarly, the lease sale could present new sources of disturbance and oil/toxic pollution that could result in the taking of Kittlitz's murrelet, a candidate species. Without comprehensive mitigation measures to avoid or minimize potential impacts, these activities may affect the Kittlitz's murrelet.

Lease Sale 193 could also present new activities that could result in the physical modification of seafloor habitats and decrease use of the Ledyard Bay Critical Habitat Area by molting spectacled eiders. Without comprehensive mitigation measures to avoid or minimize potential impacts, these activities are likely to adversely modify the Ledyard Bay Critical Habitat Area.

Marine and Coastal Birds. Marine and coastal birds could be exposed to a variety of impacts during seismic surveys, exploration drilling, and production including disturbances, collisions, habitat loss, petroleum exposure, and exposure to toxic contamination. Spilled oil has the greatest potential for affecting large numbers of birds in part due to its toxicity to individuals and their prey and the difficulties involved in cleaning up spills in remote areas, given the wide variety of possible ice conditions. Most significantly, a large spill could impact common and thick-billed murres in late summer and early fall, when juveniles and attendant males are floating throughout the Chukchi Sea. During this period, juveniles have not yet developed the ability to fly and attendant males are flightless for several weeks while molting. This inability to move quickly out of the area coupled with the potential for affecting large numbers of birds could sharply decrease murre abundance at the Cape Thompson and Cape Lisburne colonies.

There are several areas historically documented to be important to marine and coastal birds in the Sale 193 area.

These areas, as well as the entire proposed lease sale area, lack site-specific data on habitat-use patterns, routes, and timing to assess impacts. For many species, the most recent data is between 15 and 30 years old, making accurate analysis difficult. Overall, several species or species-groups have a high probability of experiencing substantial negative impacts. The risk that several regional bird populations could experience significant adverse impacts is high.

Other Marine Mammals. Based on the paucity of information available on marine mammal ecology in the Chukchi Sea and on specific locations of future developments, we are unable to determine at this time if significant impacts will or will not occur. However, significant impacts could occur to belugas and walrus in the event of a large oil spill. Significant impacts to polar bears are likely to occur if there is a large oil spill.

Careful mitigation can help reduce the effects of future industrial developments and their accumulation through time. However, the effects of full-scale industrial development of the waters of the Chukchi Sea likely would accumulate through displacement of marine mammals from their preferred habitats, increased mortality, and decreased reproductive success. Because of the lack of data it is unknown if noise introduced into the environment from industrial activities, including drilling and seismic operations, will have an adverse impact on nonendangered and nonthreatened marine mammals in the Proposed Action area. Increasing vessel traffic across the Arctic which includes the Proposed Action area, increases the risks of oil and fuel spills and vessel strikes of marine mammals.

Documented impacts to polar bears, to date, in Alaska by the oil and gas industry appear minimal. Due primarily to increased concentrations of bears on part of the coast, the potential for an oil spill to impact polar bear populations has increased in recent years. Oil spills have the greatest potential for affecting polar bears in part due to the difficulties involved in cleaning up spills in remote areas, given the wide

variety of possible ice conditions in the Chukchi Sea. A large oil spill could impact large numbers of polar bears at coastal aggregations as well as in the broken ice and lead systems offshore. Polar bear aggregations on the Russian side still are vulnerable to oil-spill impacts. Therefore, our overall finding is that, due to the magnitude of potential mortality as the result of a large oil spill, the Proposed Action would likely result in significant impacts to polar bears if a large spill occurred.

Terrestrial Mammals. Among the terrestrial-mammal populations that could be affected by oil exploration and development in the Sale 193 area are: caribou of the Central Arctic (CAH), Western Arctic (WAH), and Teshekpuk Lake caribou (TCH) herds; muskoxen; grizzly bears; and arctic foxes. 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. Effects could also come from potential oil spills contacting coastal areas used by caribou for insect relief and scavenging by grizzly bears and arctic foxes.

The effects of Chukchi Sea oil exploration and development on caribou, muskoxen, and grizzly bears would likely include local displacement within about 4 km of onshore pipelines and roads. If a large oil spill occurred in the Chukchi Sea, it likely would result in the loss of a small number of caribou, muskoxen, grizzly bears, and arctic foxes. However, significant impacts to local grizzly bear populations could occur if a large oil spill affected one of the salmon-spawning rivers in the project area.

Vegetation and Wetlands. Seismic surveys and exploration activities would be concentrated offshore, with no impacts on onshore and inland vegetation and wetlands. The level of effects on wetlands and terrestrial vegetation communities resulting from oil development and production would likely be localized. These impacts would be moderate to significant at a local scale, especially if a large spill occurred, but would have a small effect on the ecological functions, species abundance and composition of wetlands and plant communities of the North Slope at a regional scale.

Economy. Sale 193 would generate increases in North Slope Borough (NSB) property taxes that would average about 25% above the level of Borough revenues without the sales in the peak years and taper off to <15% in the latter years. In the early years of production, each sale would generate increases in revenues to the State of Alaska of <0.3% 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 <2% over the 2003 baseline for the NSB and <0.5% over the 2005 baseline for the rest of Alaska for each of the three major phases of OCS activity—exploration, development, and production. The employment and personal income increase includes workers to clean up a large oil spill of 1,500 bbl or 4,600 bbl. Sale 193 would contribute to extending the lifespan of the Trans-Alaska Pipeline (TAPS).

Subsistence-Harvest Patterns. Effects on subsistence-harvest patterns could occur as a result of oil spills, seismic survey activity, and construction-related activities. Oil spills could cause multiyear suspensions or curtailments of subsistence activities for some marine mammal resources. Construction-related activities—pipeline placement, traffic noise, heavy-equipment movement, etc.—could hinder the harvest of subsistence resources. Because of the concentration of construction-related activities and the potential for this region to be affected by any oil-spill incident that could occur over the life of the field, the communities that use this area heavily for their subsistence resources would be those most affected by sale-related activities. Conversely, the communities that lie at some distance from the concentrated areas of construction would be those that experience less sale-related effects on subsistence-related activities.

For the communities of Barrow, Wainwright, Point Lay, and Point Hope, and Kivalina, noise and disturbances periodically could affect subsistence resources. Effects on bowhead whales, beluga whales, other marine mammals, terrestrial mammals, freshwater fish, marine fish, most birds, and polar bears are expected to range from negligible to local and short term (generally <1 year) and have no regional population effects. No resource or harvest area would become unavailable or undesirable for use, and no resource would experience overall population reductions. In the case of a large oil spill, all areas directly oiled, areas to some extent surrounding them, areas used for staging, and transportation corridors for spill response would not be used by subsistence hunters for some time following a spill. 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. Oil-spill cleanup would increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to these species, and alter or extend the normal subsistence hunt. Such oil-spill effects would be considered significant.

Sociocultural Systems. In characterizing the potential adverse effects from OCS activities, we look at the magnitude and duration of disruption, with “significant” effects equated to conditions described as a chronic disruption of social organization, cultural values, and institutional organization for a period two to five years with a tendency toward displacement of existing social patterns

The effects of the 3D/2D seismic activities that are projected to occur are likely to be minimal. Effects to social well being (social systems) will be noticeable because of concern over deflection of the bowhead whale due to seismic survey activities and the attendant effects on subsistence harvest. Routine activities from exploration, development and production, and decommissioning, could cause noticeable disruption to social organization, cultural practices, and institutional organizations, especially during development, a period that will last more than 5 years. However, the combination of effects would not be sufficient to displace existing social patterns at the Regional level. On the local level, Wainwright may experience significant effects with noticeable disruption which will most likely result during development from the placement and onshore infrastructure (that is, the shore base in the scenario), with the most prominent effect the change in land use that comes about by introduction of industrialization. Wainwright could experience other effects to social organization, cultural values, and institutional organization for a period exceeding two to five years. Collectively, these other effects represent a chronic disruption. Given the resiliency of social systems and their ability to adapt, the chronic disruption can be successfully accommodated. However, the social patterns that emerge will be markedly different from the patterns that preceded development. In other words, displacement will have occurred.

For a large oil spill, noticeable disruption in excess of two years could occur from the oil spill and clean-up activities. The effects of this disruption would last beyond the period of clean up and would represent a chronic disruption of social organization, cultural values, and institutional organization. The effects would have a tendency to displace existing social patterns.

Activities associated with 3D/2D seismic surveys, exploration, development, production and decommissioning will cause some disruption to some elements of social organization, cultural practices, and institutional organization for a period of at least two years. This disruption is not expected to have a tendency to remarkably change (displace) existing social patterns at the regional (NSB) level. Effects could be significant but manageable on a local level (at Wainwright in the scenario because of supply base activity). Effects from a large oil spill could represent a chronic disruption of social organization, cultural values, and institutional organization and have a tendency to displace existing social patterns.

Archaeological Resources. 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 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 250.203; 30 CFR 250.204; 30 CFR 250.1007(a)(5); and 30 CFR 250.1010(c)); 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.

Land Use Plans and Coastal Management Program. Conflicts with the Statewide standards of the ACMP and the NSBCMP 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 Plans 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. 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. No conflicts with the statewide standards of the ACMP or with the enforceable policies of the NSBCMP are anticipated.

Environmental Justice. Alaskan Inupiat Natives, a recognized minority, are the predominant residents of the communities of Barrow, Atkasuk, Wainwright, Point Lay, Point Hope, and Kivalina, the areas potentially most affected by activities assessed in this EIS. Inupiat Natives could be disproportionately affected by disturbance impacts from seismic activity, vessel, aircraft, and construction noise, and oil spills because of their reliance on subsistence foods. "Significant" effects on Environmental Justice are defined as: disproportionately high adverse impacts to low-income and minority populations. Potential significant impacts to subsistence resources and harvests and consequent impacts to sociocultural systems could result in adverse environmental justice impacts.

Avoidance planning, stipulations and required mitigation, and conflict avoidance measures under requirements for Incidental Take Authorizations as defined by NMFS and FWS under the marine Mammal Protection Act would serve collectively to mitigate seismic and noise disturbance effects on environmental justice. Mitigating measures likely would incorporate traditional knowledge and the cooperative efforts between MMS, the State, the people of the North Slope, and tribal and local governments. With required mitigation and conflict avoidance measures in place, significant impacts to subsistence resources and hunts from seismic activity and noise and disturbance would not be expected to occur as a result of this action, thereby avoiding significant impacts on sociocultural systems and disproportionately high adverse impacts on low income and minority populations in the region—significant environmental justice impacts.

II.C.2. Alternative II – No Lease Sale.

This alternative is equivalent to cancellation of the proposed sale scheduled in the 2007-2012 5-Year Program EIS. The opportunity for development of the estimated oil and gas resources that could have resulted from the Proposed Action would be precluded or postponed, and any potential environmental impacts resulting from any of the Proposed Action would not occur or would be postponed. Because 2007-2012 5-Year Program has lease sales in the Chukchi Sea Planning Area tentatively scheduled in 2009 and 2011, this alternative would be equivalent to delaying the sale for 2 or more years.

II.C.3. Alternative III – Corridor I Deferral.

This alternative was developed by MMS in response to comments received during the scoping process. This deferral would reduce potential impacts to bowhead whale subsistence hunters from oil and gas operations. This alternative would offer for leasing all of the area described in Alternative I except for a corridor from extending 60 mi offshore along the coastward edge of the proposed sale area to protect important bowhead whale habitat used for migration, feeding, nursing calves, and breeding (Map 2). Alternative III would offer 1,765 whole or partial blocks, comprising 9.1 million acres (3.7 million hectares). This alternative would result in a reduction of 36% of the commercial resources opportunity index from the Proposed Action (see Table III.A-3). Most of the bowhead whale subsistence-hunting area used by the communities of Point Hope, Point Lay, Wainwright, and Barrow are in the Chukchi Sea, which already was deferred from leasing in the 2002-2007 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. However travel time of a spill to reach conceivably could be longer depending on currents and wind conditions.

II.C.3.a. Summary of Impacts.

The following summarizes the detailed impact analyses found in Section IV.C.2. This summary is limited to the impact of a typical Proposed Action with the Alternative III Corridor I Deferral. The impact analysis assumes that the standard lease stipulations, ITL's, and standard seismic survey stipulations are in place.

Water Quality. If the assessment scenario remains the same for Alternative I, III, or IV, the actions and sources of water quality degradation do not change but are only sited elsewhere. The deferral areas may avoid localized discharges to marine waters; however, the removal of the deferred lease blocks would not significantly affect the marine water quality either negatively or beneficially. Compliant postlease activities do not pose a significant degree of risk to water quality (Sec. IV.C.1.a). 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 may occurred elsewhere in the sale area.

Air Quality. Potential air quality impacts from Alternative III would be lower than from Alternative I because of the greater distance from shore of the nearest tract available for leasing. The difference, however, would be negligible.

Lower-Trophic-Level Organisms. The effects on lower trophic-level organisms would be due partly to possible discharges in nearshore areas and to oil spills that could contact the coastline next to the Spring Lead System (Sec. IV.C.1.c(1)). Therefore, the deferral of 1,765 whole or partial blocks near the coast would decrease the level of effects. The individual effects of Alternative III would be lower than those summarized for Alternative I in Section IV.C.1.c(1)), but the relative severity of them would be similar.

Fish Resources. This alternative would provide the largest deferral area and provide the greatest net resource benefits to fish resources. This deferral area would be in the form of a corridor on the shoreward margin of the proposed sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects further away from important fish habitats. The increased distance between offshore development and coastal fish habitats also conceivably could decrease the chance of spilled oil contacting the coastline, increase weathering of spilled oil prior to contact, and increase available spill response time.

Essential Fish Habitat. In theory, this deferral alternative would provide more protection for coastal and marine fish habitat by moving drilling and construction noise disturbances and water quality impacts (exploration and production platform discharges, turbidity) further away from the Chukchi Sea coastline.

Additional potential resource benefits could occur if a large oil spill happened because the increased distance to the shoreline conceivably reduces the percent chance of one or more spills $\geq 1,000$ bbl contacting sensitive coastal resources and the increased time required for oil to travel this greater distance would conceivably allow for a more effective response from spill response depots. The absolute changes in conditional probabilities (the percent chance that a large spill would reach coastal habitats) associated with this alternative could be quantified, but this has not been done.

At the same time, deferrals could increase pipeline distances. Increased pipeline distances could increase the potential for a pipeline spill and could result in greater pipeline construction impacts. All of the potential effect categories remain the same as the proposed action, but the anticipated impacts would be lower due to the setback from the coast. Overall, the greatest net ecological benefits to EFH would accrue from this alternative because it contains the largest deferral area.

Threatened and Endangered Species.

Threatened and Endangered Marine Mammals: This alternative would preclude the development, production, and abandonment of oil and gas activities in the lease blocks within Corridor I, thereby reducing potential conflicts between migrating bowhead whale populations, bowhead whale subsistence hunters, and offshore oil and gas operations. However, seismic surveys (if permitted by the MMS, per 30 CFR Part 251 – Geological and Geophysical Explorations of the Outer Continental Shelf) for the exploration of oil and gas resources in the Chukchi Sea Proposed Sale Area would be allowed to continue.

Differences in noise and oil-spill effects to bowhead whales from this deferral compared to Alternative I (Proposed Action) and Alternative IV (Corridor II Deferral) are difficult to quantify, but qualitatively can be described. While the selection of this alternative decreases the opportunity of discovering a commercial field and the number of oil-spill launch sites, the resources in and adjacent to this area still could be adversely affected by a large oil spill originating from a production site and/or pipeline located elsewhere

in the sale area. Therefore, the impacts of oil spills and industrial noise on threatened and endangered marine mammals, as described and analyzed in Section IV.C.1.f apply.

The deletion of this area from the lease sale would move sources of industrial noise and sources of crude oil further offshore and away from the spring lead system, thus reducing the likelihood of spring bowhead whale encounters with industrial noise. It would not, however, substantially reduce the chance of crude oil contacting the spring-migratory route because: (1) pipelines, constructed through the spring-migratory route in order to transport oil to shore-based processing facilities, could leak; and, (2) oil-spill-trajectory models indicate that depending on the volume of oil spilled and oceanographic and weather conditions, oil spilled outside Corridor I could be transported into the spring-migratory route. However, because this alternative reduces the number of potential oil-spill launch sites and their locations are further away from the spring-migratory route, any spill that would occur would conceivably take longer to reach and enter the spring-migratory route, thus allowing more time to respond to the spill. Because fall migrating bowhead whales are not expected to use the deferred area, fall bowhead encounters with oil and gas-related industrial noise and oil spills would be the same as for the base condition (Alternative I, Proposed Action).

Implementing existing MMS mitigation measures (Sec. II.B.2 - Mitigation Measures) – which include standard lease stipulations and ITL's, as identified in Chukchi Sea Oil and Gas Lease Sale 126 (1991) and/or in Beaufort Sea Planning Area multiple-sale (2003) environmental impact statements, and stipulations associated with the Programmatic Environmental Assessment, Arctic Ocean OCS Seismic Surveys (2006) – in concert with the conservation recommendations in the NMFS Arctic Region Biological Opinion (dated June 16, 2006) would provide the necessary protection to prevent and/or minimize adverse environmental impacts on the bowhead whale.

Threatened and Endangered Birds. Despite a deferral, this alternative could present new (and potentially the fewest of all action alternatives) sources of disturbance, collision hazards, and oil/toxic pollution that could result in the taking of threatened Steller's and spectacled eiders. These activities remain likely to adversely affect Steller's and spectacled eiders. Similarly, this alternative could present new sources of disturbance and oil/toxic pollution that could result in the taking of Kittlitz's murrelet, a candidate species.

This alternative could also present new activities that could result in the physical modification of seafloor habitats and decrease use of the Ledyard Bay Critical Habitat Area by molting spectacled eiders. Under this alternative, these activities are less likely to adversely modify the Ledyard Bay Critical Habitat Area compared to Alternative 1.

Marine and Coastal Birds. This alternative would provide the largest deferral area and provide the greatest net resource benefits to marine and coastal birds. This deferral area would be in the form of a corridor on the shoreward margin of the proposed lease-sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects further away from important bird habitats. The increased distance between offshore development and coastal bird habitats also would conceivably decrease the percent chance of spilled oil contacting bird habitat, increase weathering of spilled oil prior to contact, and increase available spill-response time.

Marine Mammals. Alternative III would provide the largest deferral area and provide the greatest net resource benefits to marine mammals. This deferral area would be in the form of a corridor on the shoreward margin of the proposed sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects further away from important coastal habitats. However, because of the lack of data on marine mammal distributions and habitat use in offshore areas of the Chukchi Sea, it is uncertain what the level of effects would be in offshore areas. The increased distance between offshore development and coastal habitats also would conceivably decrease the percent chance of spilled oil contact with marine mammals, increase weathering of spilled oil prior to contact with marine mammals, and increase available spill-response time.

Terrestrial Mammals. This alternative would provide the largest deferral area and would be in the form of a corridor on the shoreward margin of the proposed lease-sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects further away from important coastal habitats. The increased distance between offshore development and coastal habitats would conceivably decrease the

percent chance of spilled oil contacting coastal habitats, increase weathering of spilled oil prior to contact coastal habitats, and increase available spill-response time.

Vegetation and Wetlands. This alternative would have similar impacts on vegetation and wetlands as the Proposed Action, because there is no difference in the activities proposed onshore. See section IV.C.1.j(1) for more details on the impact analysis.

Economy. The economic effects of Alternative III would be the same as Alternative I (Proposed Action). For purposes of economic analysis, we assume that the full exploration and development scenario for each of the deferral alternatives would occur as for Alternative I. That is, the OCS activity would take place in a different area and be the same for each deferral alternative as for Alternative I.

Subsistence-Harvest Patterns. No exploration or production activities would occur in the deferral area, potentially reducing sources for chronic noise and disturbance impacts on subsistence resources, subsistence whaling, and other marine mammal hunting. Because potential launch points for oil spills would move seaward, increasing the time for spilled oil to weather, the time to mount oil-spill response, and potentially reducing contact and impact, effects on subsistence-harvest patterns are expected to be reduced. Resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area, and pipeline routes from further offshore areas still would cross deferred areas.

Sociocultural Systems. The overall effects of the alternative including those from oil spills would be approximately the same for other components of sociocultural systems described in Table IV.C-2. The reduction of effects for these components would marginally reduce but would not substantially alter the overall effects to sociocultural systems.

Archaeological Resources. The potential effects of Alternative III on archaeological resources are essentially the same as discussed for Alternative I (Proposed Action), except that areas of possible potential will be removed in the deferrals. 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. Prehistoric and historic resources both onshore and offshore will be identified by archaeological surveys and avoided or mitigated.

Land Use Plans and Coastal Management Program. Effects to land use plans and coastal management programs are essentially the same for each alternative.

Environmental Justice. Sale-specific Environmental Justice effects would derive from potential noise, disturbance, and oil-spill effects on subsistence resources, subsistence-harvest patterns, and sociocultural systems. Noise, disturbance, and oil-spill effects under Alternative III are expected to be reduced from those described for Alternative I (Proposed Action). The only substantial source of potential Environmental Justice-related effects to coastal subsistence-oriented communities on the Alaskan Chukchi Sea coastline would occur in the event of a large oil spill, which could affect subsistence resources. Such effects would represent disproportionate high adverse effects to Alaskan Natives in Chukchi Sea coastal communities—and would be considered significant Environmental Justice impacts. Potential adverse effects are expected to be mitigated substantially, though not eliminated.

II.C.4. Alternative IV – Corridor II Deferral (Agency-Preferred Alternative).

This alternative was developed from the recommendations in the NMFS 1987 Biological Opinion for the Chukchi Sea. The Biological Opinion recommended that:

Either (1) the lease blocks within 25 miles of the nearshore lead system should be deferred from the lease sale (for example see the Coastal Deferral Alternative VI [USDOJ, MMS, 1987a] for Lease Sale 109 and the Barrow Deferral Area identified by MMS during consultation for Lease Sale 97) or, (2) “if these blocks are leased, development and production activities should not be approved unless and until further consultation results in a no jeopardy opinion.”

As shown in Map 3, the deferral area identified by NMFS will result in an area comprising approximately 795 whole or partial blocks. Much of the area described by NMFS is landward of the Sale 193 program

area. The deferred area under Alternative IV (Corridor II Deferral) is a subset of the deferred area under Alternative III (Corridor I Deferral).

II.C.4.a. Summary of Impacts.

The following summarizes the detailed impact analyses found in Section IV.C.3. This summary is limited to the impact of a typical Proposed Action with the Alternative III Corridor II Deferral. The impact analysis assumes that the standard lease stipulations, ITL's, and standard seismic survey stipulations are in place.

Water Quality. As the scenario remains the same for Alternatives I, III, and IV, the actions and sources of water quality degradation do not change but are only sited elsewhere. The deferral areas may avoid localized discharges to marine waters; however, the removal of the deferred lease blocks would not significantly affect the marine water quality either negatively or beneficially. Compliant postlease activities do not pose a significant degree of risk to water quality (Sec. IV.C.1.a). 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 may occur elsewhere in the sale area.

Air Quality. Alternative IV would lower potential air quality impacts to the adjacent onshore area more than Alternative I but not as much as under Alternative III. Tracts available for leasing are nearer the shore than under Alternative III, but not as close as under Alternative I. The difference in air quality impact, however, would be negligible.

Lower-Trophic-Level Organisms. The main effects on lower trophic-level organisms would be related to possible summer exploration discharges on nearshore tracts, to possible production discharges during the winter over the life of the field, to benthic disturbance during the assumed burial of several hundred miles of production pipelines, and to oil spills that could contact the coastline (Sec. IV.C.1.c). The deferral of 795 whole or partial blocks near the coast would reduce mainly the effect of possible discharges on nearshore tracts; the other effects would stay about the same. Overall, the effects of Alternative IV on these organisms still would be local but moderate, as stated for Alternative I in Section IV.C.1.c.

Fish Resources. This alternative has a smaller deferral area than Alternative III. The deferral area would be in the form of a corridor on the shoreward margin of the proposed lease sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects further away from important fish habitats. The increased distance between offshore development and coastal fish habitats also would conceivably decrease the percent chance of spilled oil contacting fish resources, increase weathering of spilled oil prior to contacting fish resources, and increase available spill-response time. This alternative would provide the same types of net resource benefits as Alternative III, but at a reduced level.

Essential Fish Habitat. As explained under the analysis for Alternative III (Sec. IV.B.3.e), a deferral would provide more protection for coastal and marine fish habitat by moving drilling and construction noise disturbances and water quality impacts (exploration and production platform discharges, turbidity) further away from the Chukchi Sea coastline. The primary benefit of the deferral of Corridor II under Alternative IV is that it would move sources of potential adverse effects further away from important fish habitats. The increased distance between offshore development and coastal fish habitats also would conceivably decrease the percent chance of spilled oil contacting nearshore fish habitats, increase weathering of spilled oil prior to contact, and increase available spill-response time.

Threatened and Endangered Species.

Threatened and Endangered Marine Mammals. The assessment of this alternative is essentially identical to the assessment for Alternative III (Corridor I Deferral). This alternative also would preclude the development, production, and abandonment of oil and gas activities in the lease blocks within Corridor II, thereby reducing (but not as much as Alternative III) potential conflicts between migrating bowhead whale populations, bowhead whale subsistence hunters, and offshore oil and gas operations. Seismic surveys (if permitted by the MMS, per 30 CFR Part 251 – Geological and Geophysical Explorations of the Outer Continental Shelf) for the exploration of oil and gas resources in the Chukchi Sea Proposed Action Area would be allowed to continue within the corridor.

Differences in noise and oil-spill effects to bowhead whales from this deferral compared to Alternative I (Proposed Action) and Alternative III (Corridor I Deferral) are difficult to quantify, but qualitatively can be described. While the selection of this alternative decreases the opportunity of discovering a commercial field and the number of oil-spill launch sites, the resources in and adjacent to this area still could be adversely affected by a large oil spill originating from a production site and/or pipeline located elsewhere in the sale area. Therefore, the impacts of oil spills and industrial noise on threatened and endangered marine mammals, as described and analyzed in Section IV.C.1.f(1) apply.

The deletion of this area from the lease sale would move sources of industrial noise and sources of crude oil further offshore and away from the spring lead system, thus somewhat reducing the likelihood of spring bowhead whale encounters with industrial noise. It would not, however, substantially reduce the chance of crude oil contacting the spring-migratory route because: (1) pipelines constructed through the spring-migratory route to transport oil to shore-based processing facilities could leak; and (2) oil-spill-trajectory models indicate that depending on the volume of oil spilled and oceanographic and weather conditions, oil spilled outside Corridor II could be transported into the spring-migratory route. However, because this alternative reduces the number of potential oil-spill launch sites and their locations are farther away from the spring-migratory route, any spill that would occur would conceivably take longer to reach and enter the spring-migratory route, thus allowing more time to respond to the spill (but not as much response time afforded by Alternative III, Corridor I Deferral). Because fall-migrating bowhead whales are not expected to use the deferred area, fall bowhead encounters with oil and gas-related industrial noise and oil spills would be the same as for Alternative I (Proposed Action).

Implementing existing MMS mitigation measures, which include Standard Stipulations and Information to Lessees, as identified in previous EIS's and EA's (USDOJ, MMS, 1990, 2003a, 2006a), in concert with the conservation recommendations in the NMFS Arctic Region Biological Opinion (dated June 16, 2006), would provide the necessary protection to prevent and/or minimize adverse environmental impacts on the bowhead whale.

Threatened and Endangered Birds. Despite a deferral, this alternative could present new (but potentially fewer than Alternative 1) sources of disturbance, collision hazards, and oil/toxic pollution that could result in the taking of threatened Steller's and spectacled eiders. These activities remain likely to adversely affect Steller's and spectacled eiders. Similarly, this alternative could present new, but potentially fewer, sources of disturbance and oil/toxic pollution that could result in the taking of Kittlitz's murrelet, a candidate species.

This alternative could also present new activities that could result in the physical modification of seafloor habitats and decrease use of the Ledyard Bay Critical Habitat Area by molting spectacled eiders. Under this alternative, these activities are less likely to adversely modify the Ledyard Bay Critical Habitat Area compared to Alternative I.

Marine and Coastal Birds. This alternative has a smaller deferral area than Alternative III. The deferral area would be in the form of a corridor on the shoreward margin of the proposed lease-sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects farther away from important bird habitats. The increased distance between offshore development and coastal bird habitats also would conceivably decrease the percent chance of spilled oil contacting bird habitats, increase weathering of spilled oil prior to contact, and increase available spill-response time. This alternative would provide the same types of net resource benefits as Alternative III, but at a reduced level.

Other Marine Mammals. Alternative IV would provide a deferral area smaller than Alternative III and provide greater net resource benefits to marine mammals than Alternative I. This deferral area would be in the form of a corridor on the shoreward margin of the proposed sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects further away from important coastal habitats. However, because of the lack of data on marine mammal distributions and habitat use in offshore areas of the Chukchi Sea, it is uncertain what the level of effects would be in offshore areas. The increased distance between offshore development and coastal habitats also could slightly decrease the percent chance of spilled oil contacting marine mammals, increase weathering of spilled oil prior to contact coastal habitats, and increase available spill-response time.

Terrestrial Mammals. This alternative would provide a deferral area smaller than Alternative III and would be in the form of a corridor on the shoreward margin of the proposed sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects further away from important coastal habitats. The increased distance between offshore development and coastal habitats would slightly decrease the percent chance of spilled oil occurring and contacting terrestrial mammals and associated habitat, increase weathering of spilled oil prior to contacting terrestrial mammals and associated habitat, and increase available spill-response time.

Vegetation and Wetlands. This alternative would have similar impacts on vegetation and wetlands as Alternative I (Proposed Action), because there is no difference in the activities proposed onshore. See section IV.C.1.j(1) for more details on the impact analysis.

Economy. The economic effects of Alternative IV would be the same as for Alternative I. For purposes of economic analysis, we assume that the full exploration and development scenario for each of the deferral alternatives would occur as for Alternative I. That is, the OCS activity would take place in a different area and be the same for each deferral alternative as for Alternative I.

Subsistence-Harvest Patterns. No exploration or production activities would occur in the deferral area, potentially reducing sources for chronic noise and disturbance impacts on subsistence resources, subsistence whaling, and other marine mammal hunting. Because potential launch points for oil spills would move seaward, increasing the time for spilled oil to weather, the time to mount oil-spill response, and potentially reducing contact and impact, effects on subsistence-harvest patterns are expected to be reduced. Resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area, and pipeline routes from further offshore areas would still cross deferred areas. Reductions in noise, disturbance, and oil-spill effects from this deferral would provide the same types of resource benefits as described in Alternative III but at a reduced level, because the area deferred is smaller.

Sociocultural Systems. The overall effects of the alternative including those from oil spills would be approximately the same for other components of sociocultural systems described in Table IV.C-2. The reduction of effects for these components would marginally reduce but would not substantially alter the overall effects to sociocultural systems.

Archaeological Resources. The potential effects of Alternative IV for Sale 193 on archaeological resources are essentially the same as discussed for Alternative I (Proposed Action), except that areas of possible potential will be removed in the deferrals. 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. Prehistoric and historic resources both onshore and offshore will be identified by archaeological surveys and avoided or mitigated.

Land Use Plans and Coastal Management Program. The effects to land use plans and coastal management programs are essentially the same for each alternative.

Environmental Justice. Sale-specific Environmental Justice effects would derive from potential noise, disturbance, and oil-spill effects on subsistence resources, subsistence-harvest patterns, and sociocultural systems. Noise, disturbance, and oil-spill effects under Alternative IV (Corridor II Deferral) are expected to be reduced from those described for Alternative I (Proposed Action). Effects reductions from this deferral would provide the same types of resource benefits as described in Alternative III but at a reduced level, because the area deferred is smaller. The only substantial source of potential Environmental Justice-related effects to coastal subsistence oriented communities on the Alaskan coastline would occur in the event of a large oil spill, which could affect subsistence resources. Such effects would represent disproportionate high adverse effects to Alaskan Natives in Chukchi Sea coastal communities and would be considered significant Environmental Justice impacts. Potential adverse effects are expected to be mitigated substantially, though not eliminated.

SECTION III

DESCRIPTION OF THE AFFECTED ENVIRONMENT

Contents of Section III

III. DESCRIPTION OF THE PHYSICAL ENVIRONMENT III-1

III.A. Physical Environment III-1

III.A.1. Quaternary Geology III-1

III.A.1.a. Coastal Physiography III-1

III.A.1.b. Bathymetry III-2

III.A.1.c. Past Sea Levels III-2

III.A.1.d. Seafloor Geology III-3

III.A.1.e. Subseafloor Geology III-5

III.A.2. Climate and Meteorology III-6

III.A.2.a. Air Temperature III-6

III.A.2.b. Precipitation III-7

III.A.2.c. Winds III-7

III.A.2.d. Storms III-7

III.A.2.e. Changes in the Arctic III-8

III.A.3. Physical Oceanography III-8

III.A.3.a. Major Topographic Features and Water Depth III-8

III.A.3.b. Circulation and Currents III-9

III.A.3.c. Changes in Oceanography III-10

III.A.4. Sea Ice III-11

III.A.4.a. Landfast Ice III-12

III.A.4.b. Stamukhi Zone III-13

III.A.4.c. Pack-Ice Zone III-13

III.A.4.d. Leads, Polynyas, and Flaw Zone III-14

III.A.4.e. Other Sea Ice Processes III-14

III.A.4.f. Changes in Arctic Sea Ice III-15

III.A.5. Water Quality III-17

III.A.6. Air Quality III-19

III.A.6.a. Local Industrial Emissions III-20

III.A.6.b. Arctic Haze III-21

III.A.7. Acoustic Environment III-21

III.A.7.a. Existing Acoustic Environment III-22

III.A.7.b. Sound Propagation III-24

III.A.7.c. Seismic Sound III-25

III.B. Biological Environment III-27

III.B.1. Lower Trophic-Level Organisms III-27

III.B.1.a. Planktonic and Epontic Organisms III-28

III.B.1.b. Benthic Organisms III-29

III.B.1.c. Coastal Habitats III-30

III.B.1.d. Summary III-31

III.B.2. Fish Resources III-31

III.B.2.a. Major Surveys of Coastal and Marine Fish Resources and Habitats III-31

III.B.2.b. Fish Resources of Arctic Alaska and their Ecology III-33

III.B.2.c. Pacific Salmon III-38

III.B.2.d. Distribution and Abundance Trends of Fish in the Northeastern Chukchi Sea III-40

III.B.2.e. Invertebrate Fishery Resources III-42

III.B.3. Essential Fish Habitat III-42

III.B.4. Threatened and Endangered Species III-44

III.B.4.a. Threatened and Endangered Marine Mammals III-44

III.B.4.a(1) Bowhead Whale III-47

III.B.4.a(2) Fin Whale III-55

III.B.4.a(3) Humpback Whale (Central and Western North Pacific Stocks) III-58

III.B.4.b. Threatened and Endangered Marine and Coastal Birds III-61

III.B.5. Marine and Coastal Birds III-61

III.B.5.a.	Affected Species and their Habitat	III-61
III.B.5.b.	Cliff-Nesting Seabirds	III-61
III.B.5.c.	Bering Sea Breeders and Summer Residents	III-63
III.B.5.d.	High Arctic-Associated Seabirds	III-63
III.B.5.e.	Tundra-Breeding Migrants	III-64
III.B.5.f.	Waterfowl	III-65
III.B.5.g.	Shorebirds	III-69
III.B.5.h.	Raptors	III-70
III.B.6.	Other Marine Mammals	III-70
III.B.6.a.	Pinnipeds	III-71
III.B.6.b.	Cetaceans	III-76
III.B.6.c.	Marine Fissipeds – Polar Bear	III-80
III.B.7.	Terrestrial Mammals	III-86
III.B.7.a.	Caribou	III-86
III.B.7.b.	Muskoxen	III-86
III.B.7.c.	Grizzly Bear	III-88
III.B.7.d.	Arctic Fox	III-89
III.B.8.	Vegetation and Wetlands	III-89
III.C.	Social Systems	III-92
III.C.1.	Economy	III-92
III.C.2.	Subsistence-Harvest Patterns	III-94
III.C.2.a.	Subsistence Defined	III-94
III.C.2.b.	The Cultural Importance of Subsistence	III-95
III.C.2.c.	Subsistence-Harvest Patterns	III-96
III.C.2.c(1)	Community Subsistence-Harvest Patterns	III-97
III.C.2.c(2)	Annual Cycle of Harvest Activities	III-99
III.C.2.c(3)	Community Subsistence Profiles	III-99
III.C.2.d.	Arctic Climate Change	III-115
III.C.3.	Sociocultural Systems	III-116
III.C.3.a.	Social Organizations	III-117
III.C.3.b.	Cultural Values	III-117
III.C.3.c.	Institutional Organization	III-118
III.C.3.d.	Local Institutional Involvement with Development	III-122
III.C.4.	Archaeological Resources	III-122
III.C.4.a.	Offshore Archaeological Resources	III-123
III.C.4.b.	Onshore Archaeological Resources	III-124
III.C.5.	Land Use Plans and Coastal Management Programs	III-125
III.C.5.a.	Land Status and Use	III-125
III.C.5.b.	Land Use Planning Documents	III-125
III.C.5.c.	Coastal Zone Management Act	III-125
III.C.6.	Environmental Justice	III-128

III.A. Physical Environment

III.A.1. Quaternary Geology.

III.A.1.a. Coastal Physiography. The physiography of the Chukchi Sea shoreline is the result of several episodes of rising and falling sea levels and related marine-dominated, river-dominated, and ice-dominated processes acting on the coast. The major west-trending Foothills and Coastal Plain physiographic provinces that front the Brooks Range intersect the northeast-trending Chukchi coastline and influence the coastal profile as a function of the nature of the rocks exposed at the shoreline. The southern Foothills are composed predominantly of erosion-resistant Paleozoic and Mesozoic metamorphic rocks, and the northern Foothills are formed of less-deformed Cretaceous shales and sandstones. The Coastal Plain is composed of silt and decreases in relief to the north, away from the Foothills. The southern part of the Coastal Plain consists of a relatively thin blanket of silt that overlies Cretaceous bedrock but thickens considerably northward toward the Beaufort coast.

Hartwell (1973) devised physiographic classifications for the Northwestern Alaska coast from Point Hope to Point Barrow. One is based on the relief and composition of the rocks that make up the coast; the other is based on processes sculpting the coast.

III.A.1.a(1) Features and Vertical Relief. This classification divides the coast into four geographic regions based on the presence of similar coastal features and their vertical relief (Fig. III.A-1).

III.A.1.a(1)a) Southern Foothills. The shoreline is characterized by steep sea cliffs, up to 260 meters (m) at Cape Lisburne, formed in Paleozoic bedrock of the Lisburne Hills. They are generally fronted by narrow beaches. At Point Hope, nearly continuous sand-and-gravel barrier islands outline the broad Kukuk River Delta.

III.A.1.a(2)b) Northern Foothills. Like the southern Foothills region, the shore is characterized by sea cliffs. Here the cliffs are lower (75 m maximum) because of the erosion of less-resistant Cretaceous bedrock. No offshore barrier islands or large river outlets are present along this segment of coastline.

III.A.1.a(3)c) Foothills Silt Surface of the Coastal Plain. Nearly continuous sea-cliff exposures of Cretaceous bedrock with relief of 4-14 m characterize this region. The northern part of this region is fronted by nearly unbroken barrier islands with less than (<) 3 m of relief. These islands enclose the shallow Kasegaluk Lagoon, which is as wide as 7.2 kilometers (km).

III.A.1.a(4)d) Coastal Plain West of Point Barrow. This region is characterized by nearly continuous sea cliffs up to 12 m high cut into perennially frozen ice-rich sediments. Near Icy Cape and Point Franklin offshore barrier islands front the coast, enclosing shallow lagoons. Elsewhere the cliffs are abutted by narrow beaches.

III.A.1.a(5) Primary and Secondary Coasts. Hartwell (1973) further categorizes the coastline into two main coastal classes: primary coasts, shaped largely by terrestrial processes; and secondary coasts, shaped largely by marine processes. Each of these two classes is divided into two types, based on whether it is predominantly influenced by erosion or deposition (Fig. III.A-1).

III.A.1.a(5)a). Primary Coasts. Land erosional coasts (L) are shaped by subaerial erosion and are partially drowned by rising sea level. They are characterized by a nearly straight coastline with steep sea cliffs formed in bedrock. Relief on these cliffs may be well over 100 m. In some places, the cliffs are fronted by barrier deposits and protected from the open ocean. River dominated coasts (R) are formed by river discharge at the shoreline consisting of fluvial-deltaic deposits and multiple braided river channels with steep banks. Dune fields are present on some deltas where sedimentary deposits are not vegetated. Some segments of this type of coast are fronted by nearshore barrier islands, and relief is generally <5 m.

III.A.1.a(5)b) Secondary Coasts. Wave-erosional coasts (W), which are directly exposed to open ocean, are rare (Fig. III.A-1). They are characterized by sea cliffs, generally <1 m high, cut into perennially frozen

bedrock and ice-rich sediments. The cliffs are undergoing active erosion or are in near-equilibrium condition and may have a narrow beach at their base. A marine depositional coast (M) is similar to wave-erosion coasts (W) in that the coasts are eroded by waves and currents, but marine deposition is more evident here. These are fronted by barrier islands and spits that generally follow the coastal trend but are separated from the mainland by a relatively narrow body of water (<5 km). The barrier islands protect the coast from the ice, waves, and currents of the open ocean. Spits are common and partially deflect river courses where they meet the coast. Relief on these coasts generally is <5 m.

III.A.1.b. Bathymetry.

The Chukchi Sea Planning Area is located in the Arctic Ocean northwest of the Alaska Arctic coast (Map 4). The offshore area lies within a broad, low-relief continental shelf that is gently inclined to the north. The bathymetry is influenced by the underlying bedrock and by sedimentation, modified by the effects of lower sea-level stands in the Pleistocene and Holocene. The entire shelf has been episodically subaerially exposed forming a large low plain, the Bering Land Bridge, connecting northeast Russia and Alaska.

The range of water depths in the Sale Area ranges from 95 feet (ft [30 m]) to approximately 9800 ft (3,000 m). Approximately 80% of the shelf lies between the 95- and 200 ft (30-60 m) isobaths (Grantz et al., 1982). Bathymetric highs within or contiguous to the Sale 193 area are: (1) the western flank of Hanna Shoal; (2) Herald Shoal; (3) a spitlike shoal defined by the 30-m isobath northwest of Point Hope; and (4) Blossom Shoals (Map 4). Nearshore areas that are shallower than 40 m exhibit complex bathymetry characterized by ridges and troughs (Map 4). Deeper water areas are restricted to the northeast planning area and three subsea valleys that impinge on the shelf from the continental slope. Two unnamed subsea valleys dissect the shelf in the northwestern and northeastern parts of the Sale 193 area. The continental slope and head of the large Barrow Sea Valley occupy the extreme northeastern part of the planning area where maximum water depths of around 3,000 m are attained.

III.A.1.c. Past Sea Levels.

The sea level of the Chukchi Sea has shown wide fluctuations in the late Pleistocene and Holocene. Studies have shown along the Chukchi coast the existence of late Pleistocene age marine features and paleo-shorelines up to 10 m above present sea level (Brigham-Grette and Hopkins, 1995), which date from the last interglacial period (Fig. III.A-2) with an average age of around 70,000 years before present (B.P.). Accompanying this higher sea-level stand is evidence that the sea was warmer than today, that ice did not exist south of the Bering Strait, and the Arctic Ocean probably had only seasonal ice cover. Spruce pollen found in sediment indicates that these trees were present at the shores of western Alaska along the Chukchi coast and the coast of the Beaufort Sea at this time (Brigham-Grette and Hopkins, 1995); they are now only found south of the continental divide in the Brooks Range nearly 800 km away.

Subsequently, as glaciers advanced around the world during the last glacial maximum about 20,000 years B.P., sea level dropped to approximately 120 m below modern sea level (bsl) (Clark and Mix, 2002). This lowered sea level subaerially exposed the Bering Strait and the entire Chukchi seafloor forming the Bering Land Bridge (Hopkins, 1967). The Chukchi Sea coast and exposed Bering Land bridge areas were ice free at this time, as no evidence exists for glaciers north of Kotzebue Sound or on the shelf. Phillips (1991) discovered peat in sediments from a core taken from the Chukchi Sea in a water depth of 46 m and 4.6 m below the seafloor that dated to approximately 11,330 years B.P.; therefore, sea level was at least -50.6 m at that time.

A recent study of the rates of sea-level rise since the beginning of the Holocene (Darigo, et al., 2007) in the nearby Beaufort Sea shows:

- (1) at about 11,000 years ago, sea level was at or below about 50 m bsl;
- (2) after 10,500 years B.P., sea level had risen to at least 50 m bsl and flooded the Bering Strait;
- (3) between 9,000 and 7,500 years B.P., sea level rose rapidly from about 44 m bsl to 18-16 m bsl, a rate of about 1.8 centimeters (cm) per year;
- (4) sea level was about 12 m bsl by 6,000 years B.P. and reached near modern levels (within 2 m bsl) by 5,000 years B.P.; and

(5) the rates of sea level rise between 7,500 and 4,500 years B.P., at 0.3 to 0.6 cm per year, were more than ten times the present rate of 0.3 millimeters (mm) per year.

III.A.1.d. Seafloor Geology.

III.A.1.d(1) Bedrock Outcrops. During Pleistocene low sea-level stillstands, a large portion of the Chukchi shelf was subaerially exposed (Hopkins, 1967). Over large parts of the planning area, the seafloor is barren of significant sediment cover. The seafloor bedrock subcrops occur in two belts—one that trends northwest and overlies the Herald arch, the Fold and Thrust belt (Fig. III.A-3), and the southern part of the Chukchi platform; and another that is wider and trends northeast, parallel to the coast. In the central part of the planning area, folded Late Cretaceous to Tertiary strata may compose the bedrock subcrops (Thurston and Theiss, 1987).

The majority of the bedrock at the seafloor in the planning area, however, is composed of Lower Cretaceous strata in the Fold and Thrust belt and the Colville basin (Fig. III.A-3). Mesozoic and possibly some Paleozoic bedrock lie at or near the seafloor along the crest of the Herald arch along the southwest margin of the subcrop belt (Grantz et al., 1982).

III.A.1.d(2) Quaternary Sediments. Quaternary sediment cover is thin, generally 2-10 m, across most of the central Chukchi shelf (Grantz et al., 1982). The thickest Pleistocene deposits are found in the North Chukchi basin, where they may exceed 30 m in thickness. In addition, throughout the northern part of the planning area, Pleistocene and Holocene paleochannel-fill attains thicknesses locally exceeding 30 m (Figs. III.A-3, III.A-4, and III.A-5). Offshore from Wainwright, more than 24 m of Pleistocene or Holocene sediments fill the offshore extension of the Kuk River channel (Phillips and Reiss, 1984). Phillips and Reiss (1984) also documented the occurrence of up to 12 m of possible Holocene sediment within the sandbanks of the Blossom Shoals off Icy Cape.

III.A.1.d(3) Surficial Sediments. McManus, Kelly, and Creager (1969) classified and mapped sediments mantling the seafloor on the basis of grain characteristics and depositional processes. The distributions of clay, silt, sand, and gravel in the surficial sediments is shown in Figure III.A-1. Silt and clay mantle most of the Chukchi shelf and are considered to be modern sediment derived from the Yukon and other rivers that has been carried north by the Alaska Coastal Current (McManus, Kelly, and Creager, 1969). These sediments generally are poorly sorted, homogeneous, and exhibit an absence of layering due to bioturbation (Fig. III.A-1, environments G, H, and K). The highest concentrations of silt and clay are found west of Cape Lisburne and in the central Chukchi shelf.

The surface distribution of sand in the planning area is shown in Figure III.A-1. The highest sand concentrations typically occur along the course of the northeastward-flowing Alaska Coastal Current and over the shoals. Modern sand deposits off Point Hope are shaped by currents into asymmetric bedforms and are considered by McManus, Kelly, and Creager (1969) to have been derived from the nearby sea cliffs (Fig. III.A-1, environment F). Many of the areas of high sand concentration correspond to areas of asymmetric bedforms (Fig. III.A-1). Some of the concentrations of sand over the shoals and along the coast may be residual or relict (McManus, Kelly, and Creager, 1969) (Fig. III.A-1).

The highest gravel concentrations occur on the Herald Shoal and along coast, particularly north of the Lisburne Peninsula (Fig. III.A-1, environments I, J, and L). The high gravel content of surface sediments adjacent to the coast and on the Herald and Hanna shoals reflects residual or relict sediments. North of the Lisburne Peninsula, the relict sand and gravel are believed to be winnowed, submerged shoreline deposits (McManus, Kelly, and Creager, 1969). On the Hanna Shoal, the sediments are considered to be lag deposits by the winnowing of the fine fraction by currents after they are resuspended by ice gouging of the seafloor (Toimil and Grantz, 1976).

Phillips (1986a) reports gravel actively shaped into bedforms west of Cape Lisburne in 49 m of water. He speculates that these bedforms are shaped predominantly by storm-surge and wave action but cannot offer periodicity of events of the magnitude large enough to affect gravel at these depths.

III.A.1.d(4) Migrating Bedforms. Asymmetric bedform features occur in the Chukchi Sea Planning Area in water depths ranging from <15 m to approximately 65 m and at distances of up to 160 km from the

coastline (Fig. III.A-3). Because of the asymmetric profile of the bedforms, it is assumed that they are actively migrating in the direction of their steep face (Thurston and Theiss, 1987).

In the southeastern part of the planning area, small, asymmetric sand waves trending generally parallel to the shoreline are found in water depths <15 m (Grantz et al., 1982). These bedforms probably are intermittently activated by currents and waves associated with storm events and apparently are unaffected by the northward-flowing Alaska Coastal Current, which passes farther west.

Larger shore-parallel shoals in water depths between about 6 and 21 m generally occur off the capes. Grantz et al. (1982) believe that asymmetric bedforms as high as 3 m on these shoals reflect northeastward sediment transport by the Alaska Coastal Current. Northwardly migrating sandwaves between Wainwright and Peard Bay have been documented by Phillips et al. (1982).

Phillips and Reiss (1984) have mapped a group of features termed the Blossom Shoals north of Icy Cape and have concluded that they are formed in a complex hydrodynamic regime that produces northeastwardly migrating sand waves in the southern part of the shoals and westwardly migrating sand waves in the northern part. The sand waves in the southern part of Blossom Shoals appear to migrate in response to the northeastwardly flowing Alaska Coastal Current, whereas the sand waves in the northern part of the shoals migrate under the influence of a westwardly flowing countercurrent, or eddy, off the main Alaska Coastal Current.

The sand from Blossom Shoals is carried along the course of the Alaska Coastal Current and is deposited in a shore-parallel sand field near the head of Barrow Sea Valley (Fig. III.A-3, west of Wainwright). This sand field contains northeastwardly migrating bedforms in water depths ranging from 8-20 m.

Bedforms offshore from Point Hope occur in water depths of 90 m and exhibit wave heights >6 m and wavelengths of nearly 1.5 km. These bedforms are asymmetric to the south, suggesting southward migration. However, because sediment transport off the Lisburne Peninsula generally is believed to be influenced predominantly by the northeastward-flowing Alaska Coastal Current, the southward asymmetry of the bedforms is anomalous (Thurston and Theiss, 1987). These bedforms may be the result of a local eddy or countercurrent associated with the main Alaska Coastal Current, which causes a southerly backflow through this area. Alternatively, these features might have formed in a southern extension of a seasonal, southward flow regime that has been observed in the winter around Cape Lisburne (Coachman and Aagaard, 1981).

An additional area of asymmetric bedforms occurs on the central shelf (Fig. III.A-3) northwest of the bedrock outcrop belt. The U.S. Geological Survey (USGS) seismic data show sand waves in water depths greater than (>) 50 m, with wavelengths of approximately 600 m and wave heights of approximately 3 m (Thurston and Theiss, 1987). These features are located farther offshore than any other previously reported seafloor bedforms in the Chukchi Sea Planning Area.

III.A.1.d(5) Ice Gouging. The arctic ice pack covers the Chukchi shelf 7-10 months each year. In the planning area, grounded sea ice produces nearly ubiquitous but variable (in terms of density, morphology, and orientation) ice gouging of the seafloor (Fig. III.A-6).

Ice gouges are linear to curvilinear furrows produced by the dragging of an ice keel along the sea bottom. Gouges may be many kilometers long, 1-4 m deep, and tens of meters wide. The morphology of individual gouges depends on factors such as the shape of the ice keel, the type and thickness of the seafloor sediment, the type of driving force on the ice, and the relative age of the feature.

Multi-keeled pressure ridges produce numerous parallel gouges. Tabular ice bodies may produce broad, flat, and shallow ice gouges. Ice gouges in a hard bottom exhibit a rough and irregular appearance on sidescan-sonograph records (Toimil, 1978). Gouges in soft, unconsolidated sediments appear smooth on sonographs and are usually modified by wave and current action.

The distribution and density of ice gouging in the Chukchi Sea were evaluated by Toimil (1978) on the basis of nearly 9,600 track-line kilometers of sidescan sonar and fathometer data. Generally, ice-gouge density increases with latitude and seafloor angle but decreases with increasing water depth. Toimil also

observed that certain ice-gouge characteristics generally were restricted to specific water-depth intervals (Fig. III.A-6). Gouges in water depths <35 m tend to be wider, deeper, larger, and more linear, and have a lower density than those in shallower water. Ice gouging is most pervasive along the eastern flank of the Barrow Sea Valley and northeast flank of Hanna Shoal (Fig. III.A-6). Toimil and Grantz (1976) investigated a bergfield at Hanna Shoal and determined that ice gouging has modified the texture of the sedimentary substrate by disturbing and resuspending the finer fraction. Winnowing leaves the coarser fraction as a lag deposit. Similar lag deposits have been reported on the Herald Shoal by McManus, Kelly, and Creager et al. (1969).

The relative age of ice gouging is determined from the superposition of gouges and recent sedimentary structures. Toimil (1978) identified “fresh-looking” ice gouges (current ripples adjacent to but not within the gouges) in 43 m of water and considered these to be the deepest water modern gouges in the Chukchi Sea. However, in the northern part of the planning area, ice gouges that appear to be recent (based on the sharpness and depth of furrows) are found in 49 m of water.

Ice gouge trends show no preferred regional orientations. This may be because of the variable wind patterns and complex current circulation on the shelf. Locally, gouging is roughly parallel to bathymetric contours, especially in areas of steep slope gradient and on the northwest side of shoals on the inner shelf. Gouge trends become more scattered with distance from the coast.

III.A.1.e. Subseafloor Geology.

III.A.1.e(1) Shallow Gas. Areas of acoustic anomalies typical of interstitial or free gas at shallow depths (<330 m) have been mapped from high-resolution seismic reflection data by Grantz et al. (1982) and Thurston and Theiss (1987) (Fig. III.A-3). Water column anomalies, probably representing gas rising from the sea floor, have been noted on some industry site-survey data in areas of subsurface acoustic anomalies (Thurston, 2007).

In the northern part of the planning area and east-central shelf, acoustic “turbidity” or “wipe-out” zones are found in paleochannels of Pleistocene age. These anomalies might be due to the presence of unconfined shallow gas of biogenic origin. No acoustic anomalies identified on high-resolution profiles were recognizable on multi-channel seismic-reflection profiles through the same location (Thurston and Theiss, 1987).

In the North Chukchi basin, acoustic anomalies have been identified on seismic-reflection profiles within possible Tertiary strata. The anomalies typically are characterized by acoustic “wipe-outs,” or zones of attenuated seismic signal, which commonly exhibit “pull-down” of reflections at their margins. These anomalies may represent the presence of either biogenic or thermogenic gas. Depending on the depth, the presence or absence of an effective seal, and the trapping mechanism, some accumulations could be overpressured.

Acoustic anomalies mapped in shallow Cretaceous strata are not as well defined on seismic-reflection profiles as those found in younger strata. In the belt of Cretaceous bedrock that lies between the Tertiary pinch-out lines of the North Chukchi and Northern Hope basins (Fig. III.A-3), the acoustic anomalies often are manifested as amplitude-enhanced reflections (bright-spots). These features possibly are caused by the entrapment of gas in a porous unit below a shallow sealing layer. The gas reduces the velocity of the porous layer and enhances the acoustic impedance at the interface between the gas-bearing and sealing layers. Some anomalies in this area exhibit acoustic “turbidity” or “wipe-out” similar to features seen on profiles through younger strata in areas to the north and south (Thurston and Theiss, 1987).

Anomalies identified within Cretaceous rocks in the subcrop belt, although less well-defined and abundant than those in younger strata, probably are more likely to represent shallow thermogenic gas. Support for this speculation is provided by the presence of large accumulations of thermogenic gas in correlative Cretaceous rocks onshore in the National Petroleum Reserve-Alaska (NPR-A). Offshore, this gas may be trapped near the seafloor in dipping strata sealed by Quaternary sediments, in the apexes of anticlines, or adjacent to faults.

III.A.1.e(2) Buried Channels. Buried channels are abundant in the central and northern parts of the planning area (Figs. III.A-3, III.A-4 and III.A-5). They form in crosscutting, generally north-trending, drainage complexes and are probably early Pleistocene to Holocene in age. Many events are represented by channels cut into Late Cretaceous bedrock and into all successive layers of overlying Pleistocene and Holocene sediments (Thurston and Theiss, 1987). Analysis of high-resolution seismic data from industry site surveys conducted in the late 1980's and early 1990's (Fig. III.A-4) show at least three episodes of channeling (Thurston, 2007). Although older channel complexes are harder to distinguish because they are obscured by overlying younger ones, depths to the center of the oldest channels are as deep as 90-130 m bsl, while overlying channels are generally 70-75 m bsl, and the youngest channels have bases that are generally 55-65 m bsl. These different channel episodes and their channel bottom depths probably represent erosional baselines for different lower sea-level stands. In situ peat deposits found in 46 m of water in the Chukchi Sea dated to 11,330 years B.P. (Phillips, 1991), along with evidence that buried terrestrial features such as channels and lagoons in waters <20 m in the Beaufort Sea are <9,000 years old (Diargo, et al, 2007), strengthen the possibility that the buried channels are features of the last glacial maximum drowned and modified by subsequent rising sea levels.

III.A.1.e(3) Permafrost. The distribution and occurrence of permafrost along the coast of the Chukchi Sea is sparse or non-existent. In the Sale 193 area, the presence and distribution of subsea permafrost is largely unknown (Grantz et al., 1982; Thurston and Theiss, 1987). Subsea permafrost is not yet recognized in most seismic data from the Chukchi Sea (Sellman and Hopkins, 1984). Rogers and Morack (1982) recognized ice-bonded material from seismic data collected in 5 m of water north of Icy Cape. Subzero temperatures observed in shallow, nearshore boreholes indicate that ice-bearing subsea permafrost becomes thin or absent at approximately 1 km offshore (Osterkamp and Harrison, 1982).

The presence of extensive subsea permafrost on the Beaufort shelf (Craig et al., 1985) suggests that some subsea permafrost may exist along the northwest coast of Alaska. However, no anomalous near-surface seismic velocities that would indicate the presence of ice-bonded sediments have been reported. The near-surface consolidated rock present throughout much of the Chukchi shelf may have inhibited development of permafrost during lowered sea level (Grantz et al., 1982). Another explanation for the apparent lack of relict permafrost offshore is that it was melted by the relatively warm currents moving north from the Bering Sea.

III.A.1.e(4) Earthquakes. Only a very few earthquakes have occurred in historic times in the planning area (Thurston and Theiss, 1987: Fig. 69). The Chukchi Sea Planning Area shows some faults that offset the seafloor (Thurston and Theiss, 1987) and may indicate recent faulting in the southwestern part of the planning area near the Herald arch and in the central part of the planning area (Fig. III.A-3).

III.A.2. Climate and Meteorology.

The Chukchi Sea is a sub-Arctic (high-latitude) marine region situated off the northwestern coast of Alaska. The region is characterized by moderate winds, cold temperatures during the winter, cool temperatures in the summer, and little annual precipitation. Table III.A-1 summarizes climate data from four coastal communities located along the Chukchi Sea coast.

Weather patterns in the region are strongly influenced by climate variability termed the Arctic Oscillation (AO) (Thompson and Wallace, 1998). This phenomenon is similar to the El Niño-Southern Oscillation that dominates the equatorial Pacific Ocean. The AO alternates between positive and negative phases, influencing the weather patterns throughout the Arctic and Northern Hemisphere. Starting in the 1970's, the AO has tended to stay in the positive phase, causing lower than normal Arctic air pressure and higher than normal temperatures.

III.A.2.a. Air Temperature.

The region is dominated by subfreezing temperatures for most of the year, and the Chukchi Sea is almost totally ice covered from early December to mid-May. Winter mean air temperatures range between 0 degrees Fahrenheit (°F) and -22 °F, while extremes of -50 °F and below have been recorded. During the winter, winds can be severe and prolonged, leading to extreme ice pressures and dangerous wind-chill conditions for personnel.

A brief warm and snow-free season follows in June, July, and August. Summer air temperatures average from 35-42 °F, with highs in the mid-70's °F. At the height of summer (mid-September), the Chukchi is normally 80% free of ice (Mulherin, Sodhi, and Smallidge, 1994). The summer melt pattern primarily is influenced by the influx of warmer water from the Bering Sea. Breakup initiates in the eastern portion of the Chukchi and progresses westward. Winter freezeup usually is delayed into September or October by this warmer inflow, and open water is found into late November.

III.A.2.b. Precipitation.

The general air circulation is dominated by a region of high pressure generally located over the Beaufort Sea. The Siberian High is south and west of the Beaufort High. Eastward-moving western-Pacific storm centers remain south of 60° N. latitude. Low-pressure systems, with strong southeasterly winds, occasionally move northeasterly through the Bering and Chukchi seas into the Arctic basin, bringing unseasonably warm air and moisture to the region.

Summer atmospheric-pressure patterns are more numerous and varied than the winter patterns (Barry, 1979). Western-Pacific low-pressure systems are more common north of 60° N. latitude. These systems move northeasterly through the Bering Sea into the Chukchi Sea, where they follow the northwestern Alaska coast. Low-pressure systems generally bring cloudy skies, frequent precipitation, and southwesterly winds. During the winter, the Beaufort-Chukchi Sea region is dominated by a ridge of high pressure linking the Siberian High and high pressure over the Yukon of Canada.

Fogs, rains, and snowstorms are dangerous weather phenomena that influence horizontal visibility. Very low visibility (<1 km) has two minimums annually. The summer minimum is caused by a high frequency of fog; the winter minimum is caused by a high frequency of snowstorms. From June through August, the occurrence of low visibility in the open sea ranges from 25-30% (Proshutinsky, Proshutinsky, and Weingartner, 1998). This value decreases toward the mainland coast (10%). During the central winter months, the occurrence of low visibility does not increase more than 10-15%, because snowstorms causing visibility of <1 km are infrequent.

III.A.2.c. Winds.

The region as a whole tends to have moderate winds of 3-5 meters per second (m/s) much of year. Winds exceeding 10 m/s are fairly unusual, however, and tend to occur mainly from October through March and near the coast (Olsson, Hinzman, and Sturm, 2000). Wind-direction regimes are evident and vary by season. During the winter, northerly winds prevail in the Chukchi Sea, with directions ranging from northwest in the western part of the sea to northeast in the eastern part (Proshutinsky, Proshutinsky, and Weingartner, 1998). During the summer, the Chukchi Sea exhibits a more complicated wind regime, with alternating north and south winds.

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

III.A.2.d. Storms.

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

The region can experience severe storms. On October 3, 1963, an intense storm hit Barrow with little warning and causing more damage than any other storm in its historical records. Wind gusts as high as 75-80 miles per hour (mph) (33-36 m/s) may have been reached, and the highest official observation of sustained winds was 55 mph (25 m/s). The resulting storm surge (or rise in sea level) reached 10 ft, and may have been as high as 12 ft. The storm surge and wave action caused extensive flooding in coastal areas, and >200,000 cubic yards (yd³) of sediment transport caused bluffs in the Barrow area to retreat as much as 10 feet during the storm (Brunner et al., 2004).

Since then, at least 30 storms have produced severe winds at Barrow and along the Chukchi coast. Some of these storms are more notable than others in terms of their intensity and impacts:

- September 12 and 20, 1986: The first of these storms from the southwest had peak and sustained winds of 56 and 38 mph, respectively, but the second storm was even stronger, with peak and sustained winds of 65 and 49 mph. Estimated damage to roads and structures in Barrow and Wainwright was more than \$7.5 million.
- February 25, 1989: This storm hit from the southwest when the ice was in, with peak and sustained winds of 73 and 55 mph, respectively, and reported gusts close to 100 mph. An estimate of total damage to the North Slope Borough, including both private and public property, was more than \$500,000.
- August 10, 2000: This storm hit from the west when the ice was out, with peak and sustained winds of 75 and 55 mph, respectively, equivalent to the October 1963 storm but not as long lasting. The initial total damage estimate was about \$7.7 million.

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

Table III.A-2 shows the mean annual temperature and temperature trend from 1949-2003 based on a best linear fit for Barrow and Kotzebue. The data show a warming trend for both Barrow and Kotzebue of 3.1 °F and 2.9 °F, respectively, over this 54-year period. Table III.A-2 shows that most of the temperature change in Barrow and Kotzebue has occurred in winter and spring, with less of a change in the summer and autumn. The fluctuation in annual average temperature and precipitation from 1901-2004 for Barrow and Kotzebue, respectively, is shown in Figures III.A-8 through III.A-11.

Throughout Alaska, the period 1949-1975 was substantially colder than the period from 1977-2003; however, since 1977, little additional warming has occurred in Alaska with the exception of Barrow and a few other locations (Alaska Climate Research Center, 2005). The Alaska Climate Research Center notes that a stepwise shift appears in the Alaska temperature data (Fig. III.A-10) in 1976. This shift corresponds to a pattern of variability in the ocean and atmosphere centered in the North Pacific (known as the Pacific Decadal Oscillation) that is causing increased southerly flow and warm air advection into Alaska during the winter, and the corresponding positive temperature anomalies.

Information based on traditional knowledge also points to changes in the climate of the Arctic. Since the late 1970's, Alaskan Natives in communities along the coast of the northern Bering and Chukchi seas have noticed substantial changes in the ocean and the animals that live there. Beginning in the late 1970's, the patterns of wind, temperature, ice, and currents in the northern Bering and Chukchi seas have changed. The winds are stronger, commonly 15-25 mph, and there are fewer calm days. The wind may shift in direction but remains strong for long periods. In spring, the winds change the distribution of the sea ice and combine with warm temperatures to speed up the melting of ice and snow. From mid-July to September, there has been more wind from the south, making for a wetter season. With less sea ice and more open water, fall storms have become more destructive to the coastline (Pungowiyi, 2005).

III.A.3. Physical Oceanography.

The Chukchi Sale 193 area lies within a portion of the Chukchi Sea adjacent to northern Alaska. The Chukchi Sea extends west from Point Barrow, Alaska to the Russian Chukotka shoreline, northwest to Wrangel Island and south to the Bering Strait. It is a shallow marginal sea to the Arctic Ocean. The physical oceanography is influenced by: (1) the flow of water through the Bering Strait and the Siberian Coastal Current; (2) the atmospheric-pressure systems; (3) surface-water runoff; (4) density differences between watermasses; and (5) seasonal and perennial sea ice.

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

Approximately 98% of the Sale 193 area covers the relatively shallow continental shelf adjacent to the Arctic Ocean. A small area in the north eastern portion overlies the continental slope and abyssal plain. Water depths within the sale area range from approximately 98-9,514 ft (30-2,900 m). Hanna Shoal lies within the sale area and Herald Shoal is adjacent to it on the western side. These shoals rise above the

surrounding seafloor to approximately 20 m below sea level. There are two major sea valleys in the Chukchi Sea; Herald Canyon and Barrow Canyon. The Barrow Sea Valley begins north of Wainwright and trends in a northeasterly direction parallel to the Alaskan coast. Herald Valley is to the north, adjacent to Wrangel Island, outside the sale area. Hope Valley, a broad depression, stretches from Bering Strait to Herald Canyon. These topographic features exert a steering effect upon the oceanographic circulation patterns in this area.

III.A.3.b. Circulation and Currents.

A generalized picture of the circulation is shown in Map 5. Three watermasses move through the Bering Strait: Anadyr Water, Bering Shelf Water, and Alaska Coastal Water. These watermasses cross the Chukchi Shelf and exit in four general areas: Long Strait, Herald Canyon, the Central Channel, and Barrow Canyon (Woodgate, Aagaard, and Weingartner, 2005). From the northwest, the Siberian coastal current flows south along the Chukotka Peninsula and is present in summer and fall but weak in fall and winter. On the northern continental slope, the Atlantic Intermediate Water of the Arctic Ocean circulates at depth in a counterclockwise motion. Above the Atlantic Intermediate Water is a shelf-break jet moving east (Pickart, 2004; Pickart et al., 2005). Closer yet to the surface is the Beaufort Gyre, which circulates in a clockwise motion.

From the Bering Sea, water moves north through the Chukchi Sea into the Arctic Ocean (Coachman and Aagaard, 1988). The flow through the Bering Strait is driven by a mean sea-level slope (approximately 0.5 m) to the north. Annual transport shows seasonal variation with winter transport averaging a third of the summer transport (Coachman and Aagaard, 1988; Roach et al., 1995; Cherniawsky et al., 2005). Woodgate, Aagaard, and Weingartner (2005) report monthly mean velocities of approximately 10 cm/s and 30 cm/s for January and June, respectively, but then emphasize uncertainty on the order of 20% on these estimates. Annual mean transport is 0.8 ± 0.2 Sverdrups (Sv) (Sverdrup is a unit of volume transport equal to 1,000,000 cubic meters per second [m^3/s]) (Roach et al., 1995). The flow through the Bering Strait can reverse under strong northerly winds. The freshwater that flows through the Bering Strait is important to the Chukchi Sea establishing its watermasses and to the larger Arctic Ocean freshwater budget (Woodgate and Aagaard, 2005; Shimada et al., 2001; De Boer and Nof, 2004).

Three watermasses move through Bering Strait's eastern and western channels. Anadyr water moves through the western channel, in the Russian Exclusive Economic Zone. The Anadyr Current is nutrient-rich, deeper Bering Sea water that is upwelled onto the shelf in the Gulf of Anadyr. It flows west to east in the region south of Bering Strait throughout the year and is the major forcing function for high production in the region.

The two other watermasses, the Bering Shelf Water (BSW) and the Alaska Coastal Water (ACW), enter the Chukchi Sea through the eastern Bering Strait channel. These two watermasses are distinguished by salinity differences (Aagaard, 1987). The BSW is more saline, forms in the northern-central Bering Sea, and flows northward through the western Bering Strait parallel to the bathymetry. In the Chukchi Sea, Anadyr and BSW mix to form the Bering Sea Water.

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

Flow in the Chukchi Sea generally is northward from the Bering Strait and in general is topographically steered. The mean transport can be interrupted by wind-forced currents, and the variations can be large (Weingartner et al., 1998; Woodgate, Aagaard, and Weingartner, 2005). Three generalized pathways of northward flow are recognized. Along the Alaskan Chukchi Coast is the ACW, a portion of which is within the Alaska Coastal Current (ACC) and exiting through Barrow Canyon. A portion of the water entering Bering Strait moves northward along the Hope Valley and drains through Herald Canyon to the

Arctic Ocean. The third path flows through the Central channel between Herald and Hannah shoal and may return to flow through Barrow Canyon or flow off the shelf into the Arctic basin.

The influence of Kotzebue Sound on the Chukchi Sea may be significant in reinforcing the ACC. The ACC flows northeastward along the Chukchi Sea coast at approximately 5 cm/sec and drains into the Barrow Canyon (Johnson, 1989; Weingartner et al., 1998). The mean transport for Barrow Canyon is not well documented but is estimated at approximately 0.3 Sv (Pickart et al., 2005). The ACC flow is variable, and reversals in direction can persist for several weeks (Wilson et al., 1982; Aagaard, 1984; Weingartner et al., 1998); a large part of the flow variability is wind driven. Thus, during the summer, the ACW may be absent from some parts of the Chukchi Sea coastal area because of prolonged (southerly) flow reversal or offshore diversion (Aagaard, 1984). Feder et al. (1989) determined that the coastal region of the northeast Chukchi Sea responds rapidly (within 6 hours) to wind forcing from Point Barrow to Point Hope. During northeasterly flow, anticyclonic (clockwise) eddies can separate the nearshore circulation from the ACC, between Cape Lisburne and Icy Cape (Wiseman and Rouse, 1980); off Icy Cape (Hufford, Thompson, and Farmer, 1977); and in Peard Bay (Hachmeister and Vinelli, 1985).

Strong, persistent, northward flow has been observed in Barrow Canyon (Woodgate and Aagaard, 2005). Both ACW and winter transformed Bering Water is found in Barrow Canyon. At the head of the canyon they flow side by side. By the time they reach the mouth, ACW overlies winter transformed Bering Water (Pickart et al., 2005). Barrow Canyon's mean currents range from 14-23 cm/s, with maximum current speeds of approximately 100 cm/s (Weingartner et al., 1998). Flow reversals occur in Barrow Canyon with upwelling of Atlantic water onto the shelf. These reversals are tied to the pressure gradient associated with the variable longshore current (Johnson, 1989; Aagaard and Roach, 1990).

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

A large polynya, or a series of polynyas, form off the Alaskan coast during winter (Stringer and Groves, 1991). Polynyas preferentially occur along coasts with offshore winds, as is frequently the case in the eastern Chukchi Sea between Point Hope and Barrow during winter. During some fall and winter seasons, salt rejection occurs during the formation of sea ice in these polynyas. This creates dense, cold, super salty watermasses and causes a seaward flow of the denser water (Cavaliere and Martin, 1994; Winsor and Bjork, 2000). These dense waters may be advected to deeper water by eddies (Winsor and Chapman, 2002). There is disagreement between the polynya area and the amount of ice production leading to salinity forcing (Martin et al., 2004; Weingartner et al., 1998). In some years, freezing in polynyas is insufficient to produce a dense, cold, super salty watermass.

Tides are small in the Chukchi Sea, and the range generally is <0.3 m. Tidal currents are largest on the western side of the Chukchi and near Wrangel Island, ranging up to 5 cm/s (Woodgate, Aagaard, and Weingartner., 2005).

III.A.3.c. Changes in Oceanography.

We do not know to what extent the recent changes in the Arctic Ocean are cyclic, whether they represent a linear trend, or if they are a modal shift. Changes in the Bering Sea as well as the Arctic Ocean have complex interactions with the Chukchi Sea.

Widespread changes of temperature and salinity occurred in the central Arctic Ocean water column during the 1990's. There were observations of widespread temperature increases in the Atlantic water layer (Carmack et al., 1995; McLaughlin et al., 1996; Morrison, Steel, and Anderson, 1998; Grotefendt et al., 1998). These appear related to an increased temperature (Swift et al., 1998) and strength (Zhang, Rothrock,

and Steele, 1998) of the Atlantic inflow into the Arctic Basin. Increased transport caused a displacement of the Pacific-Atlantic water boundary toward the Canadian Basin. The pronounced warming of Atlantic water in the central basin tapered off by 1998-1999 (Gunn and Muench, 2001; Boyd et al., 2002). Kikuchi, Inoue, and Morison (2005) report that the temperature anomalies appear first on the Markov Basin side of the Lomonosov Ridge and then arrive on the Amundsen side of the basin approximately 7 years later. Karcher et al. (2003) suggest, from modeling, that the warming of the Atlantic Layer resulted from changes in inflow from Fram Strait and the Barents Sea as well as changes in local current speeds. They suggest these events are episodic with a warming event in the early 1980's and again in the early 1990's. Woodgate et al. (2001) and Zhao, Gao, and Jiao (2005) also present observations of warming and cooling events near the Chukchi Borderlands. There still is discussion in the literature regarding the cause of the warming. Carmack and Chapman (2003) discuss increasing upwelling of warm Atlantic water along the shelf break due to the reduction of sea ice and an increase in wind-driven circulation.

Shimada et al. (2005) and McLaughlin et al. (2005) identify the remnants of this warmed Atlantic Water recently reaching the Canada Basin. Comparisons of recent and historical data show that the Canada Basin waters are in transition and are responding to inflow from upstream basins (McLaughlin et al., 2004, 2005). The appearance of higher temperatures near the Chukchi Plateau suggests that temperatures may continue to increase adjacent to the Chukchi shelf in the coming years. Steele et al. (2004) state that the distribution of summer Pacific halocline is changing in the Canada Basin of the Arctic Ocean and so is its influence. They relate these changes to the two different AO states where during a high AO, ACW and summer Bering Shelf Water may outflow at different locations from the Arctic. During a low AO, both watermasses are mixed into the Beaufort Gyre, and the separation of these watermasses is reduced.

Determining whether this trend persists depends on acquiring additional data. Polyakov et al. (2005) report two warm Atlantic Water anomalies (1999 and 2004) in the eastern Eurasian Basin that could propagate towards the Arctic Ocean interior with a time lag. Polyakov et al. (2004) present data showing multidecadal fluctuations in temperature, with time scales of 50-80 years for Atlantic Water temperature variability.

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

Lynch et al. (2001) examined 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. The longer open-water period and the increase in storm events could lead to increased storm-surge events.

III.A.4. Sea Ice.

The sea ice descriptions in Chukchi Sea Sales 97, 109, and 126 Final Environmental Impact Statements (USDOI, MMS, 1987a,b, 1990a) are incorporated by reference. Brief summaries of these descriptions, augmented by new material are provided below.

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

There are three general forms of sea ice in the Sale 193 area: (1) landfast ice, which is attached to the shore, is relatively immobile and extends to variable distances offshore; (2) stamukhi ice, which is grounded and ridged ice; and (3) pack ice, which includes first-year and multiyear ice, which moves under the influence of winds and currents. These general ice types vary spatially and temporally in the sale area and are strongly influenced by the bathymetry and location of offshore shoals as well as the atmospheric-pressure fields.

In the Sale 193 area, sea-ice extent has a large seasonal cycle, generally reaching a maximum extent in March and a minimum in September. There is a large amount of interannual variability in the formation and breakup patterns of sea ice. In the Sale 193 area, there also are large differences in timing from north to south with the northern portions freezing first and melting last and the southern portions freezing last and melting first. Some generalizations follow.

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

By about mid-May, the nearshore ice and thin ice begin to melt; by July, the pack ice in the sale area begins retreating northward. Even in September when there is maximum open water, ice may be present in the northern sale area (Stringer and Groves, 1985). The relative locations of the ice edge during the time of maximum ice-free water in the Chukchi Sea are shown in Figure III.A-13 for the period 1996 through 2004.

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

III.A.4.a. Landfast Ice.

The mean annual cycle of landfast ice begins in October and grows slowly through February. Freezing begins in late August to early September; first ice appears anywhere from late October to late December. Stable landfast ice appears from mid-January to mid-March. Thawing begins about late May, and breakup occurs from about late May to mid-June. Table III.A-3 shows a comparison of mean occurrence dates compared to Barry, Moritz, and Rogers (1979) (Eicken et al., 2006, 2007). The growth of landfast ice is not continuous and can involve formation breakup and reformation. The monthly mean extent is greatest in March or April and then begins to melt and break up (Eicken et al., 2006, 2007). Overall, there is a gradual formation of landfast ice and a rapid retreat. Landfast ice in the Chukchi is not as stable as in the Beaufort. The landfast ice does not reach its final modal depth until April and, therefore, is not as stable as the central Beaufort, which reaches it modes in January and February (Eicken et al., 2006, 2007). Landfast ice formed near Barrow measured 1.67 ± 1.0 m (Eicken et al., 2005)

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

In the very shallow (2 m and less), inner part of the landfast zone, the ice freezes to the seafloor; in the outer part, the ice floats. Movement of ice in the landfast zone (called ice shoves or *ivu* by the Inupiaq) is intermittent and may occur at any time but is more common during freezeup and breakup. Ice-shove

motion is associated with several factors, including compaction of offshore sea ice, closure of coastal flow lead, onshore winds, and warming of the landfast ice. The warming of the landfast ice reduces its strength and stability. Onshore winds are highly correlated with ice shoves.

Huntington, Brower, and Norton (2001) report a 1957 ice shove on the landfast ice related to them by the residents and elders at the Barrow Symposium on Sea Ice. Extreme rates of ice movement—up to 2.3 m/sec—were reported in the Chukchi Sea off Barrow during a storm in December 1973 (Shapiro, 1975); the ice was about 0.6 m thick, and the winds blew at about 26 m/s, with gusts up to 52 m/s. A 450-ft onshore movement was reported in Barrow in December 1978. Mahoney et al. (2004) report on two ice shoves, one approximately 5 m and another approximately 45 m, on the beach and 145-170 and 395 m offshore, respectively, affecting Barrow and Wainwright in 2001. The movement of ice toward the shore may result in pileups or rideups on the beaches and offshore islands. There is a large variability in the behaviors of ice over various scales (Mahoney et al., 2004) with the bathymetry playing a large role in the behavior. In January 2006, a large ice shove occurred in and around Barrow creating ice 20-40 ft high for miles along the coast (Talbot, 2006). The elders believe that the current, not the wind, drives the *ivu* (Leavitt, as reported by Talbot, 2006).

Landfast-ice breakouts, where the landfast ice breaks off from the shore, occur along the northern Alaska coast. Breakouts can occur at any time of the year. Breakouts where the new landfast ice edge is within 1 km of the coast tend to occur most often at the end of the annual seasonal ice cycle (Blazey, Mahoney, and Eiken, 2005).

III.A.4.b. Stamukhi Zone.

The ice zone that lies seaward of the landfast ice has been referred to as the *stamukhi* (shear or flaw) zone. This zone is a region of dynamic interaction between the relatively stable ice of the landfast-ice zone and the mobile ice of the pack-ice zone that results in the formation of ridges, leads, and polynyas (large areas of open water). In the Chukchi Sea, the region of most intense ridging occurs in waters that vary in depth from 15-40 m deep; moderate ridging extends seaward and shoreward of these regions. Grounded ridges help to stabilize the seaward edge of the landfast-ice zone.

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

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

The pack-ice zone lies seaward of the *stamukhi* zone and includes: (1) first-year ice; (2) multiyear floes, ridges, and floebergs; and (3) ice islands.

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

Historically, first-year floes off the Chukchi Sea coast had a thickness of about 1.2-1.5 m and multiyear floes were 3-5 m thick. Sea ice that is thicker than 5 m is common in the Arctic Ocean pack ice and is generally believed to consist of pressure ridges and rubble fields. Chukchi Sea ice cores measured in 2002 were 0.8-2.39 m, although ice type could not be readily determined (Eicken et al., 2005). As a result of melting and refreezing, multiyear ridges are stronger than first-year ridges. Other thick masses of sea ice include floebergs and ice islands. Floebergs are hummock or rubble fields that are frozen together. Ice islands are large, tabular icebergs with areal sizes ranging up to 1,000 square kilometers (km²) or more and thicknesses up to 60 m (Sackinger et al., 1985).

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

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

III.A.4.d. Leads, Polynyas, and Flaw Zone.

A system of 7 recurring leads and polynyas develop within the Chukchi Sea. Figure III.A-14 shows their generalized location. Some polynyas develop between the landfast- and pack-ice zones extending the length of the Chukchi coast from Point Hope to Barrow during the winter and spring adjacent to the Sale 193 area (Stringer and Groves, 1991). Between February and April, the average coastal lead-system width is <1 km (the extreme widths range from a few kilometers in February to 75-80 km in April) and is open about 50% of the time. Table III.A-4 shows the mean and maximum width characteristics of the polynyas along the coast measured from 1990-2001 by Martin et al. (2004). Figure III.A-15 shows the maximum polynya and flaw lead for 1995, 1997, 2003, and 2004.

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

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

The overall behavior of the Chukchi Sea open-water system from late spring to early fall is summarized as follows: (1) during May and June, the average width is about 4 km at the northern end but widens to about 100 km at the southern end (there are, however, large variations in the width and the system is a more or less permanent feature); (2) through July and August, the average width increases dramatically (extreme widths of several hundred km can occur), but the open-water system in the vicinity of Point Barrow and Wainwright may be closed; (3) September is the period of maximum open water; and (4) the freezeback process begins in October.

III.A.4.e. Other Sea Ice Processes.

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

III.A.4.e(1) Sea Ice Drift. Drifting arctic sea ice plays a significant role in the redistribution of both sediments and contaminants (Pfirman et al., 1995, 1997). Based on a modeling effort in conjunction with arctic buoy data, drifting sea ice generally drifts from the polar basin to the Chukchi Sea during summer or

from the Chukchi to the polar basin during summer (Pavlov, Pavlova, and Korsnes, 2004). Estimated travel time for sea ice from the Chukchi Sea to Fram Strait ranges from approximately 4-10.7 years based on travel times from Bering Strait and the Mackenzie River mouth.

III.A.4.e(2) Ice Gouging. At depths shallower than 60 m, linear depressions have been gouged into the seafloor by the keels of drifting ice masses. Ice gouging occurs in the Sale 193 area. Historical information from 20 years ago indicates areas of high ice-gouge density along the coast. Along the coast, areas of high ice-gouge density include the steep slopes of the seafloor in the Barrow Sea Valley or ice-push-sediment ridges, the stamukhi zone, and the shoals adjacent to the capes (Lewbel, 1984). The orientation of the gouges is usually parallel to the isobaths on the steep slopes and shoals, but in water <15 m deep the orientation may be random. Between Point Barrow and Icy Cape, the maximum observed gouge-incision depth generally increases slightly from 2.4 m at 12 m of water depth to 2.8 m at 24 m of water depth. Below 28-30 m, the gouge-incision depth decreases with increasing depth; this decrease may reflect the thin sediment cover, about 1-2 m in waters >30 m, or the presence of bedrock at or near the surface, which would prevent gouges from forming. Reworking of sediments by currents in the stamukhi zone also may eliminate the traces of many ice gouges.

Contemporary ice gouging may be occurring in water at least 43 m deep. In the central part of the Sale 193 area, beneath the ACC in water depths of 43-45 m, ice gouges were observed cutting across sand-ripple fields that may be active under present-day current regimes. The currents also transport the sediments that partially or completely fill in the gouges. The recurrence interval of ice gouging on the seafloor of the Chukchi Sea is unknown at this time.

Quantitative information on ice gouges is sparse to nonexistent in the Chukchi Sea, except for localized surveys. Ice-gouge data were last collected on a regional basis more than 20 years ago, when instrument and navigation quality was less accurate than current technology. The MMS has collated all of the available ice-gouge and strudel-scour data for site-specific surveys and development surveys in the Beaufort Sea and is just beginning this effort in the Chukchi. At this time, there are insufficient interpreted data to predict the occurrence, extent, and magnitude of these features in a quantitative fashion for the region as a whole.

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

The arctic sea ice is undergoing changes. There are reported changes in sea-ice extent, thickness, distribution, age, and melt duration.

The analysis of long-term data sets indicate substantial reductions in both the extent (area of ocean covered by ice) and thickness of the arctic sea-ice cover during the past 20-40 years, with record minimum summer extent in 2002 and again in 2005, and extreme minima in 2003, 2004 and 2006 (Stroeve et al., 2005; NASA, 2005; Comiso, 2006a). In September 2002, summer sea ice in the Arctic reached a record minimum during summer, 4% lower than any previous September since 1978 and 14% lower than the 1978-2000 mean (Serreze et al., 2003). Three years of low ice extent followed 2002. Taking these 3 years into account, the September ice-extent trend for 1979-2004 declined by -7.7% per decade (Stroeve et al., 2005) and from 1979-2005 declined by -9.8% per decade (Comiso, 2006a). Within the Arctic, the Chukchi and Beaufort Seas have some of the largest declines in sea ice extent during summer. In 2005, the Beaufort Sea was not as wide open as the previous 3 years (Comiso, 2006a).

The analysis of 2005 and 2006 arctic winter ice sea ice shows record low ice extent and area (Comiso, 2006b). The reported values are approximately 6% lower than average for each year (Comiso, 2006b). Polykov et al (2003) studied the long-term variability of August ice extent from 1900-2001 and reported a $1 \pm 0.9\%$ decrease per decade for the Chukchi Sea.

While changes in the reduction of sea ice are apparent, the cause(s) of change is ambiguous. Lindsay and Zhang (2005) hypothesize that the thinning of sea ice, based on a combination of modeling and analysis of data; is due to:

- (1) the fall, winter, and spring air temperatures over the Arctic Ocean have gradually increased over the last 50 yr, leading to reduced thickness of first-year ice at the start of summer;
- (2) a temporary shift,

starting in 1989, of two climate indices caused a flushing of older, thicker ice out of the basin and an increase in the summer open water extent; and (3) the increasing amounts of summer open water allow for increasing absorption of solar radiation which melts the ice, warms the water and promotes creation of winter first-year ice that often entirely melts by the end of the subsequent summer.

Francis et al. (2005) suggest that downwelling long-wave radiation fluxes account for a large percentage of the variability of perennial sea-ice extent in the Beaufort and Chukchi sea area. In the Chukchi Sea, meridional wind (one with a strong north-south component) also had an influence but played a lesser role in the Beaufort. Watanabe et al. (2006) suggest the Arctic dipole anomaly contributes to sea ice export during its positive stage. Shimada et al. (2006) present evidence that the pattern of sea-ice extent is similar to the distribution of warm Pacific summer water. Kwok (2004) and Kwok, Maslowski, and Laxon (2005) identify and discuss the implications of multiyear-ice distribution both in terms of an unusual outflow of multiyear ice into the Barents Sea and its consequences as a freshwater source to the transformation of Atlantic Water circulating in the Arctic.

The extent of Arctic amplification continues as a point of debate in the scientific literature. Arctic amplification is described as an increase in temperature in the Arctic regions over the lower latitudes. Serreze and Francis (2006) conclude that the condition of a general warming, longer melt seasons and thinning and retreating of the sea ice are those which the effects of natural variability will be acted upon.

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

Changes in the landfast ice have been occurring. Events of shorefast ice breaking off have occurred near Barrow in January or February and even as late as March (George et al., 2003). These events also have increased in frequency. Polykov et al (2003) estimate that the long-term trends for fast ice thickness in the Chukchi Sea are small, from 1900-2000. Most of these data are from the Russian side of the Chukchi Sea. Through modeling studies, Dumas, Carmack, and Melling (2005) postulate that air temperature and snow accumulation are a large factor in determining the duration of landfast ice in the Beaufort Sea. As air temperature rises, landfast ice duration is shorter. Eicken et al. (2006) suggest that an earlier onset date of thawing in spring is responsible for the earlier breakup of landfast ice in the Beaufort and Chukchi seas.

The distribution of age class of ice in the Arctic has changed. During the late 1980's and the early 1990's, a large portion of old ice (>10 years) was flushed out of the Arctic through Fram Strait (Rigor and Wallace, 2004). Kwok (2007) states that the replacement of multiyear ice at the end of 2005 summer was near zero. He reports that from June through September 2005 the export through Fram Strait was the highest compared to a seven year average from 2000-2006 (Kwok, 2007). Belchansky, Douglas, and Platonov (2005) report a pronounced loss of old ice in the western Arctic at a rate of -4.2% annually and an increased prevalence of young ice through 2003 due to atmospheric circulation anomalies in the early 1990's. The largest declines in multiyear ice concentration (-3.3% yr⁻¹) occurred in the southern Beaufort and Chukchi Seas (Belchansky, Douglas, and Platonov, 2004). The two prominent hypotheses on the loss of multiyear ice are the flushing factor through the Transpolar drift out of the Arctic (Kwok, 2004; Rigor, and Wallace, 2004) and loss of multiyear ice with the addition of general rise in arctic temperatures (Rothrock and Zhang, 2004; Lindsay and Zhang, 2005; Francis et al., 2005)

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

III.A.5. Water Quality.

Water quality is a term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose (<http://ga.water.usgs.gov/edu/waterquality.html>). A waterbody in its natural state is free from the harmful effects of human-generated pollution, habitat loss, and other negative stressors. It is characterized by a particular biological diversity and abundance.

The general water quality of the Alaska Arctic region OCS is relatively pristine due to the remoteness, harsh but active ecological system, and limited presence of human (anthropogenic) inputs. Industrial impacts are minimal; degradation of the arctic OCS water quality primarily is confined almost exclusively to external intrusions and naturally occurring processes. Pollution occurs at very low levels in Arctic waters and/or sediments and does not pose an ecological risk to marine organisms in the OCS. The majority of the water flowing into the marine environment is not subject to human activity or stressors and is considered unimpaired (State of Alaska, Dept. of Environmental Conservation [ADEC], 2004).

Important water column properties include temperature, salinity, and density. Temperature and salinity records show a strong annual cycle of freezing, salinization, freshening, and warming, with sizable seasonal variability. The largest seasonal variability is seen in the east where warm, freshwaters escape from the buoyant, coastally trapped Alaskan Coastal Current into the interior Chukchi (Woodgate, Aagaard, and Weingartner, 2005; Deep Sea Research <http://psc.apl.washington.edu/HLD/Chukchi/Chukchipaper.html>).

Water quality in the nearshore Arctic Ocean (landward of the 40-m water-depth line) may be slightly affected locally by both anthropogenic and natural sources. Most detectable pollutants occur at very low levels in arctic waters and/or sediments and do not pose an ecological risk to marine organisms (USDOI, MMS, 2003b). There are no Section 303(d) impaired waterbodies identified within the Arctic Subregion by the State of Alaska (ADEC, 2004).

The Chukchi Sea averages about 50 m deep. It is seasonally ice covered and it is influenced by the autumn and winter atmospheric storms carried north through Bering Strait. As a shallow sea, even its depths are within reach of the influence of the atmosphere. The Chukchi Sea is fed by Pacific waters entering the Chukchi Sea via Bering Strait in the south, and Arctic waters entering the Chukchi Sea via Long Strait. The circulation and relative quality of waters in the Chukchi Sea influences the input to the Arctic Ocean from the Pacific. The regional throughflow in the Bering-Chukchi is large, and the flow carries large amounts of nutrients, resulting in remarkably high summer productivity on the Bering-Chukchi shelf (Woodgate, Aagaard, and Weingartner, 2005; Circulation in the Chukchi Sea <http://psc.apl.washington.edu/HLD/Chukchi/Chukchi.html>). Bering Strait acts as the Pacific gateway to the Arctic Ocean, and all Pacific waters found in the Arctic must cross the Chukchi to reach the Arctic Ocean.

Once in the Arctic, the Pacific waters play three major roles: (1) they bolster the warm/cold (halocline) layers of the Arctic Ocean water column; (2) they provide nutrients for arctic ecosystems; and (3) they are an important part of the freshwater balance of the Arctic Ocean. Each role depends critically on the volume and properties of the waters exiting the Chukchi Sea into the Arctic Ocean.

The structure of these properties within the water column is arranged in different layers. Water on the inner shelf (<50 m) is well mixed, and temperature and salinity are uniform within a single layer most of the time. On the middle shelf (50-100 m), a two-layer temperature and salinity structure exists because of downward mixing of wind and upward mixing due to relatively strong tidal currents (Kinder and Schumacher, 1981). On the outer shelf (100-200 m), a three-layer temperature and salinity structure exists due to downward mixing by wind, horizontal mixing with oceanic water, and upward mixing from the bottom friction due to relatively strong tidal currents. Oceanic water structure is present year-round beyond the 200-m isobath.

The mean residence time for Pacific waters in the Chukchi is about 4 months but is much longer in winter than summer, corresponding to the stronger northerly winds and weaker currents during winter. This large seasonal variability likely has major consequences for the shelf ecosystem, e.g., for nutrient cycling. Winter watermass modification over the Chukchi shelf depends on the fall and winter winds, which control the seasonal evolution of the ice. For example, an extensive ice cover during fall reduces cooling, limits new ice formation, and results in little salinization of the water column. In such years, Bering shelf waters

cross the Chukchi with little modification, even along the Alaskan coast. On the other hand, extensive open water in fall leads to early and rapid cooling and, if accompanied by vigorous ice production within coastal polynyas (areas of open water surrounded by sea ice), results in the production of high salinity waters in the eastern Chukchi. Such interannual variability likely affects mixing processes over the slope and the depth at which Pacific waters intrude into the Arctic Ocean interior.

http://www.onr.navy.mil/sci_tech/32/reports/docs/hl/03/hlaagaar.pdf.

The Chukchi Sea cools in autumn, salinizes in winter, and warms and freshens in spring/summer. Details of and deviations from these transitions lead to a greater understanding of the physical processes affecting watermass properties in the Chukchi.

Temperature records show an even clearer seasonal evolution. Temperatures start to fall before ice is present and reach the surface-freezing temperature before ice is at 100% coverage. Generally, the temperature rises above the freezing point as the ice concentration falls from 100%, and the waters continue to warm after all the ice is gone.

Generally, from January through April, during the freeze, the Bering Strait waters are the saltiest and densest in the Chukchi.

<http://psc.apl.washington.edu/HLD/Chukchi/WoodgateetalTextOct04.pdf>.

A waterbody in its natural condition is free from the harmful effects of pollution, habitat loss, and other negative stressors. It is characterized by a particular biological diversity and abundance of organisms.

Biological assessments are evaluations of the condition of waterbodies using surveys and other direct measurements of resident biological organisms (macroinvertebrates, fish, and plants). Biological assessment results are used to answer the question of whether waterbodies support survival and reproduction of desirable fish, shellfish, and other aquatic species—do the waterbodies meet their designated aquatic life uses.

Protecting the future productivity of these ecosystems is important. Alaska's continental shelf supports the richest diversity of marine mammals in the Northern Hemisphere, and almost half of the Nation's fishery volume. Other important economic activities also share in the use of this ocean environment. Although the mineral wealth of the region is still undetermined, 18% of the Nation's domestic oil now comes from the Alaska coastal zone. http://gcmd.nasa.gov/records/GCMD_ARCSS011.html.

The current through the Gulf of Alaska is known as the Alaska Current. It flows westward and, in the eastern Aleutians, turns northward to bring warm water along the western coast of Alaska all the way to Point Barrow. The coastline of the Bering Sea, except for part of the southern Seward Peninsula, is mostly shallow, with offshore bars and lagoons. Most of the coast of the Chukchi and Beaufort seas is similar. The Bering Sea contains ice during the winter, and the marginal region of the ice is one of the world's major fisheries. In summer, the ice slowly retreats northward into the Arctic Ocean, allowing navigation along the Arctic Coast by late summer. http://encarta.msn.com/text_761569148_37/Alaska.html.

Temperature and salinity records show a strong annual cycle of freezing, salinization, freshening, and warming, with sizable interannual variability. The largest seasonal variability is seen in the east, where warm, freshwaters escape from the buoyant, coastally trapped Alaskan Coastal Current into the interior Chukchi. In the west, the seasonally present Siberian Coastal Current provides a source of cold, freshwaters and a flow field less linked to the local wind. <http://psc.apl.washington.edu/HLD/Chukchi/WoodgateetalTextOct04.pdf>. The salinity cycle in the Chukchi can be considered as being set by the input through Bering Strait and, because density is dominated by salinity at these temperatures, Bering Strait salinities are a reasonable predictor of ventilation of the Arctic Ocean.

Observations in Chukchi Sea are complicated by sea ice, which is present for about 6 months of the year.

Within the Chukchi Sea, the Anadyr (western Bering Strait waters) and the Bering Shelf waters merge into a watermass named Bering Sea Water. An important distinction here is the nutrient content of the waters—those with Anadyr origin (generally found in the western Chukchi) are far richer in nutrients than the Alaskan Coastal Water found in the eastern Chukchi (Walsh et al., 1989).

Water quality degradations, where they occur, are largely related to seasonal biological activity and naturally occurring processes, such as water-column stratification due to temperature differentials, seasonal plankton blooms (occurring primarily in spring and fall), naturally occurring oil/hydrocarbon seeps, seasonal changes in water turbidity due to terrestrial runoff, and formation of surface water ice. Marine water quality conforms to the Environmental Protection Agency (USEPA) criteria for the protection of marine life.

The main rivers that flow into the Arctic marine environment remain relatively unpolluted by human activities. They do, however, carry into the marine environment sediment-suspended particles with some trace metals, hydrocarbons, and other pollutants. The closest and largest industrial impacts to water quality in the Chukchi area would be the Red Dog Mine. The Red Dog mine is located approximately 66 mi upstream from the village of Kivalina in the Northwest Arctic Borough. It is operated by Teck Cominco Alaska on lands owned by the NANA Regional Corporation. Discharges from the Red Dog Mine flow into tributaries of the Wulik River, which provides drinking water to Kivalina. In March 2004, a San Francisco advocacy group acting on behalf of five current residents of Kivalina initiated a citizens' suit under the Clean Water Act against Teck Cominco Alaska. In the citizens' suit litigation, the court found that Teck Cominco Alaska did not meet the total dissolved solids (TDS) requirements of its 1998 discharge permit at Red Dog, even though the TDS amount discharged was within the limit authorized by the USEPA. In addition to paying a significant penalty for its multiple violations of the Clean Water Act, the settlement requires Teck Cominco Alaska to assess the extent of current and potential ground- and surface-water contamination, and to take steps to prevent future harm to the marine life and the watershed in and around the Red Dog Mine.

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

Winter watermass modification over the Chukchi shelf depends on the preceding autumn and early winter winds that, in turn, control the seasonal evolution of the ice. Extensive ice cover during autumn reduces cooling, limits new ice formation, and results in little salinization of the water column. In such years, Pacific waters entering through the Bering Strait cross the Chukchi shelf with little modification. However, extensive open water in autumn leads to early and rapid cooling and, if accompanied by vigorous ice production within coastal polynyas, results in production of high-salinity waters in the eastern Chukchi. Such interannual variability likely affects mixing processes over the slope as well as the depth at which Pacific waters intrude into the Arctic Ocean interior.

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

Background hydrocarbon concentrations in the Chukchi waters appear to be biogenic and on the order of 1 part per billion (ppb) or less. Hydrocarbon concentrations in the Hope Basin and Chukchi Sea are entirely biogenic in origin and are typical of levels found in unpolluted marine waters and sediments (USDOJ, MMS, 1996a,b).

III.A.6. Air Quality.

The USEPA uses six "criteria pollutants" as indicators of air quality and has established for each of them a maximum concentration above which adverse effects on human health may occur. These threshold concentrations are called National Ambient Air Quality Standards (NAAQS). When an area does not meet the air quality standard for one of the criteria pollutants, USEPA may designate it as nonattainment area.

The USEPA may use such a classification to specify what air pollution reduction measures an area must adopt, and when the area must reach attainment.

The air quality of the Chukchi Sea area is well within the NAAQS and State of Alaska ambient air quality standards (18 AAC 50). The area is relatively pristine; there are few nearby industrial emission sources and no sizable population centers. Because concentrations of criteria pollutants are far less than federal and state standards, the Chukchi area is classified as an attainment area under the Clean Air Act.

Air emissions from OCS facilities in the Chukchi Sea would be regulated by USEPA, which has jurisdiction for OCS air quality as prescribed in 40 CFR Part 55. For facilities located within 25 mi of a State's seaward boundary, the air quality criteria would be the same as if the emission source were located onshore, and would be subject to State of Alaska standards. For facilities located beyond 25 mi of a State's seaward boundary, the basic Federal air quality regulations apply. These would include the USEPA New Source Performance Standards (NSPS) and Prevention of Significant Deterioration (PSD) regulations. Table III.A-5 lists the ambient air quality standards for the planning area.

Air emissions from OCS oil and gas development in the Chukchi Sea would arise from emission sources on drilling and production platforms and from support vessels, including ships, barges and helicopters, and accidental releases of oil.

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. There are not significant industrial emission sources in close proximity to the planning area.

The most significant sources of industrial emissions are located at the Prudhoe Bay/Kuparuk/Endicott oil-production complex, over 200 mi to the east, and the Red Dog Mine, approximately 125 mi southeast of the southern planning area boundary. The Prudhoe oilfield 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-5. All the values meet the State and Federal ambient air quality standards. The results appear to demonstrate that ambient pollutant concentrations from oil and gas development, even for sites subject to maximum concentrations, would meet the ambient air pollution standards. This is true even if we assume the baseline PSD program concentrations (determined on a site-specific basis) to be zero, limiting the allowable increase in concentrations.

The Red Dog Mine is the world's largest zinc mine; it has been producing since 1989. This facility operates under an Air Quality Title V operating permit issued by the ADEC. Ore containing lead sulfide and zinc sulfide is mined and milled to produce concentrated lead and zinc powder. These concentrates are trucked year-round from the mine along a 55-mi long road through Cape Krusenstern National Monument to the shallow-water port for storage and eventual loading onto ships when the port is ice-free, only about 100 days a year. A moss study performed in 2000 by the National Park Service (NPS) found elevated concentrations of metals in the tundra along the road and near the port, apparently resulting from escaping (fugitive) dust from operations along the transportation corridor. The NPS findings raise the possibility of airborne heavy-metal contributions from mining activities not only to the haul-road corridor (via ore-concentrate escapement) but also to the Omikviorok River drainage as a whole. The operator of the mine, Teck Cominco Alaska, has made a number of operational changes in the past few years to reduce fugitive dust from its operations and is conducting a remedial investigation to assess the public health and environmental impacts of fugitive dust deposited along the transportation system. Subsequent review by the ADEC did not disclose any violation of air-permit provisions relating to the control of fugitive dust from the mine (ADEC, 2005). Teck Cominco Alaska also has been monitoring the air in Noatak and Kivalina to determine the levels of lead in airborne dust in both villages. Results from both communities indicate lead levels are approximately 200 times below the NAAQS for lead (Teck Cominco Alaska, 2005). Particulate matter has also been monitored; results demonstrate compliance with both the daily and annual NAAQS for PM₁₀.

III.A.6.b. Arctic Haze.

Although the measurements do indicate that the air quality standards are being met throughout the Alaskan Arctic, some pollution nevertheless has occurred. For example, Hattie Long stated: “We get a lot of yellow haze out of Prudhoe all year long...since the time that the haze started hovering over Nuiqsut” (U.S. Army Corps of Engineers, 1996).

Gaseous and fine particulate matter in the atmosphere can potentially degrade atmospheric visibility. The most important source of visibility degradation is from particulate matter in the 1- to 2-micron (μ) size range, emitted primarily through fuel burning and through chemical transformation of NO_2 , sulfur dioxide (SO_2), and volatile organic compounds (VOC) into nitrates, sulfates, and carbonaceous particles. The phenomenon of arctic haze, which occurs in northern Alaska in winter and spring, is attributed primarily to long-range transport of pollutants from sources on the Eurasian continent (ADEC, 2002)

During winter, the arctic atmosphere becomes contaminated with anthropogenic pollution transport from industrial Europe and Asia (Rahn, 1982). This regional air pollution consists of approximately 90% sulfate aerosols and 10% soot (Wilcox and Cahill, 2003). The lack of moisture and sunlight during the winter means that very little SO_2 is oxidized into sulfate (SO_4). Consequently, the majority of sulfur that reaches Alaska in winter remains as SO_2 . As sunlight returns to the Arctic, arctic haze reaches its peak intensity around March, when much of the built up SO_2 is oxidized into ammonium sulfate, ammonium bisulfate, and sulfuric acid (Wilcox and Cahill, 2003). The particles scatter light very effectively and cause significant reduction in visibility.

Europe and Russia appear to be the main contributors of long-range transport of sulfur and fine particles to the Arctic. Maximum concentrations of some pollutants, sulfates and fine particles, were observed during the early 1980's; observers measured decreases at select stations at the end of the 1980's (Pacyna, 1995). The decline in atmospheric sulfur in the Arctic is due to decreased emissions. Reductions in Europe have occurred as a result of intentional improvements in environmental practices. In contrast, decreasing sulfur emissions in Russia have occurred because of increased use of natural gas for fuel rather than coal, as well as the sharp economic contraction that followed the dissolution of the Soviet Union. The decline in emissions from Russia, however, may be in the process of reversing as a consequence of economic revitalization and its increasing reliance coal for domestic energy consumption as natural gas becomes more valuable for export (Wilcox and Cahill, 2003).

Pollutant sulfate due to arctic haze in the air in Barrow (that in excess of natural background) averages 1.5 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 <10% of the pollutants emitted in the major source regions is deposited in the Arctic (Pacyna, 1995). Despite this seasonal, long-distance transport of pollutants into the Arctic, regional air quality still is far better than standards require.

III.A.7 Acoustic Environment.

There is a great deal of naturally occurring noise in the ocean from volcanic, earthquake, wind, ice, and biotic sources (see Richardson et al., 1995a:Chapter 5). Ambient noise levels affect whether a given sound can be detectable by a receiver, including a living receiver, such as a whale. In addition, ambient-noise levels can change greatly throughout the course of a season at a particular site, and vary from site to site.

Sounds generated by the oil and gas industry in the Arctic are propagated into a marine environment that already receives sounds from numerous natural and human sources. Ambient noise levels in the Beaufort and Chukchi seas can vary dramatically between and within seasons because of: (1) variability in components of environmental conditions such as sea ice, temperature, wind, and snow; (2) the presence of marine life; (3) the presence of industrial shipping, research activities, and subsistence activities; and (4)

other miscellaneous factors. In general, the ambient noise in the Arctic marine environment varies widely and seasonally. In the Beaufort Sea, Burgess and Greene (1999) measured ambient noise in September from about 63 to 133 dB re 1 μ Pa. A complete description of all producers of noise is beyond the scope of this document. The main sources of noise, both natural and anthropogenic (manmade), occurring in the Beaufort and Chukchi seas are described below.

III.A.7.a. Existing Acoustic Environment.

The acoustic environment of the Arctic Subregion varies greatly among seasons and between specific areas. During much of the year, in many marine areas in this subregion, there are few near-field marine-noise sources of human origin and limited, but increasing, land-based and nearshore-based sources of noise that affect the OCS in the Arctic Subregion.

III.A.7.a(1) Natural Sound. Natural sound sources in the Beaufort and Chukchi seas include the wind stirring the surface of the ocean, lightning strikes; animal vocalizations and noises (including whale calls, echolocation clicks, and snapping shrimp); subsea earthquakes; and ice movements.

The presence of ice can contribute significantly to ambient noise levels and affects sound propagation. As noted by the National Research Council (NRC) (2001:39), "An ice cover radically alters the ocean noise field..." with factors such as the "...type and degree of ice cover, whether it is shore-fast pack ice, moving pack ice and...floes, or at the marginal ice zone..." and temperature, all affecting ambient noise levels. The NRC (2001, citing Urick, 1984) reported that variability in air temperature over the course of the day can change received sound levels by 30 dB between 300 and 500 Hertz (Hz).

Temperature affects the mechanical properties of the ice, and temperature changes can result in cracking. In winter and spring, land-fast ice produces significant thermal cracking noise (Milne and Ganton, 1964). In areas characterized by a continuous fast-ice cover, the dominating source of ambient noise is the ice cracking induced by thermal stresses (Milne and Ganton, 1964). The spectrum of cracking ice noise typically displays a broad range from 100 Hz-1 kiloHertz (kHz), and the spectrum level has been observed to vary as much as 15 dB within 24 hours due to the diurnal change of air temperature. Ice deformation occurs primarily from wind and currents and usually produces low frequency noises. Data are limited, but at least in one instance it has been shown that ice-deformation noise produced frequencies of 4-200 Hz (Greene, 1981). As icebergs melt, they produce additional background noise as the icebergs tumble and collide.

While sea ice can produce significant amounts of background noise, it also can function to dampen ambient noise. Areas of water with 100% sea-ice cover can reduce or completely eliminate noise from waves or surf (Richardson et al, 1995a). As ice forms, especially in very shallow water, the sound propagation properties of the underlying water are affected in a way that can reduce the transmission efficiency of low frequency sound (see Blackwell and Greene, 2002). The marginal ice zone, the area near the edge of large sheets of ice, usually is characterized by quite high levels of ambient noise compared to other areas, in large part due to the impact of waves against the ice edge and the breaking up and rafting of ice floes (Milne and Ganton, 1964). In the Arctic, wind and waves (during the open-water season) are important sources of ambient noise with noise levels tending to increase with increased wind and sea state, all other factors being equal (Richardson et al., 1995a).

At least seasonally, marine mammals can contribute significantly to the background noise in the acoustic environment of the Beaufort and Chukchi seas. Frequencies and levels are highly dependent on seasons. For example, source levels of bearded seal songs have been estimated to be up to 178 decibels re 1 microPascal at 1 meter (178 dB re 1 μ Pa at 1 m) (Cummings et al., 1983). Ringed seal calls have a source level of 95-130 dB re 1 μ Pa at 1 m, with the dominant frequency under 5 kHz (Richardson et al., 1995a). Bowhead whales, which are present in the Arctic Region from early spring to mid- to late fall, produce sounds with estimated source levels ranging from 128-189 dB re 1 μ Pa at 1 m in frequency ranges from 20-3,500 Hz. Richardson et al. (1995a) summarized that most bowhead whale calls are "tonal frequency-modulated (FM)" sounds at 50-400 Hz. There are many other species of marine mammals in the arctic marine environment whose vocalizations contribute to ambient noise including, but not limited to, the gray whale, walrus, ringed seal, beluga whale, spotted seal, fin whale (in the southwestern areas) and, potentially

but less likely, the humpback whale. In air, sources of sound will include seabirds (especially in the Chukchi Sea near colonies), walruses, and seals.

III.A.7.a(2) Anthropogenic Sound. Human sources include noise from vessels (motor boats used for subsistence and local transportation, commercial shipping, research vessels, etc.); navigation and scientific research equipment; airplanes and helicopters; human settlements; military activities; and marine development. Table III.A-7 provides a comparison of manmade sound levels from various sources associated with the marine environment.

Vessel Activities and Traffic. Shipping noise, often at source levels of 150-190 dB re 1 μ Pa, since 1950 has contributed a worldwide 10- to 20-dB increase in the background noise in the sea (Andrew et al., 2002; McDonald, Hildebrand, and Wiggins, 2006). The types of vessels that produce noise in the Beaufort and Chukchi seas include barges, skiffs with outboard motors, icebreakers, scientific research vessels, and vessels associated with geological and geophysical exploration and oil and gas development and production. In the Beaufort and Chukchi seas, vessel traffic and associated noise presently is limited primarily to late spring, summer, and early autumn.

In shallow water, vessels more than 10 km away from a receiver generally contribute only to background noise (Richardson et al., 1995a). In deep water, traffic noise up to 4,000 km away may contribute to background-noise levels (Richardson et al., 1995a). Shipping traffic is most significant at frequencies from 20-300 Hz (Richardson et al., 1995a). Barging associated with activities such as onshore and limited offshore oil and gas activities, fuel and supply shipments, and other activities contributes to overall ambient noise levels in some regions of the Beaufort Sea. The use of aluminum skiffs with outboard motors during fall subsistence whaling in the Alaskan Beaufort Sea also contributes noise. Fishing boats in coastal regions also contribute sound to the overall ambient noise. Sound produced by these smaller boats typically is at a higher frequency, around 300 Hz (Richardson et al., 1995a).

Icebreaking vessels used in the Arctic for activities including research and oil and gas activities produce louder, but also more variable, sounds than those associated with other vessels of similar power and size (Richardson et al., 1995a). Even with rapid attenuation of sound in heavy ice conditions, the elevation in noise levels attributed to icebreaking can be substantial out to at least 5 km (Richardson et al., 1991). In some instances, icebreaking sounds are detectable from more than 50 km away. In general, spectra of icebreaker noise are wide and highly variable over time (Richardson et al., 1995a).

Oil and Gas Development and Production Activities. There currently are a few oil-production facilities on artificial islands in the Beaufort Sea. Typically, noise propagates poorly from artificial islands, as it must pass through gravel into the water (Richardson et al., 1995a). Typically, noise propagates poorly from artificial islands, as it must pass through gravel into the water (Richardson et al., 1995a). Richardson et al. (1995a) reported that during unusually quiet periods, drilling noise from ice-bound islands would be audible at a range of about 10 km, when the usual audible range would be ~2 km. Richardson et al. (1995a) also reported that broadband noise decayed to ambient levels within ~1.5 km, and low-frequency tones were measurable to ~9.5 km under low ambient-noise conditions, but were essentially undetectable beyond ~1.5 km with high ambient noise. Much of the production noise from oil and gas operations on gravel islands is substantially attenuated within 4 km and often not detectable at 9.3 km.

Recently Richardson (2006) summarized results from acoustic monitoring of the offshore Northstar production facility from 1999-2004. Northstar is located on an artificial gravel island in the central Alaskan Beaufort Sea. In the open-water season, in-air broadband measurements reached background levels at 1-4 km and were not affected by vessel presence. However, Blackwell and Greene (2004) pointed out that "...an 81 Hz tone, believed to originate at Northstar, was still detectable 37 km from the island." However, based on later measurements, that tone was not repeated in future years. Based on sounds measurements of noise from Northstar obtained during March 2001 and February-March 2002 (during the ice-covered season), Blackwell, Greene, and Richardson (2004) found that background levels were reached underwater at 9.4 km when drilling was occurring and at 3-4 km when it was not. Irrespective of drilling, in-air background levels were reached at 5-10 km from Northstar.

During the open-water season, vessels such as tugs, self-propelled barges, and crew boats were the main contributors to Northstar-associated underwater sound levels, with broadband sounds from such vessels

often detectable approximately 30 km offshore. In 2002, sound levels were up to 128 dB re 1 μ Pa at 3.7 km when crew boats or other operating vessels were present (Richardson and Williams, 2003). In the absence of vessel noise, averaged underwater broadband sounds generally reached background levels 2-4 km from Northstar. Underwater sound levels from a hovercraft, which British Petroleum Exploration (Alaska) (BPXA) began using in 2003, were quieter than similarly sized conventional vessels. Hovercraft also replaced helicopter traffic to the Northstar facility.

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

III.A.7.a(3) Potential Effect of Climate Change. Available evidence indicates that the total extent of arctic sea ice has declined over the past several decades; these declines are not consistent across the Arctic (Gloersen and Campbell, 1991; Johannessen, Miles, and Bjorgo, 1995; Maslanki, Serreze, and Barry, 1996; Parkinson et al., 1999; Vinnikov et al., 1999). Warming trends in the Arctic (Comiso, 2003) appear to be affecting thickness of multiyear ice in the polar basin (Rothrock, Yu, and Maykut, 1999) and perennial sea-ice coverage (declines 9% per decade) (Comiso, 2002a,b).

The presence, thickness, and movement of sea ice significantly influence the ice's contribution to ambient noise levels. The presence of sea ice also affects the timing, nature, and possible locations of human activities such as shipping; research; barging; whale hunting; oil- and gas-related exploration (e.g., seismic surveys and drilling); military activities; and other activities that introduce noise into the marine environment. Because of sea ice and its effects on human activities, ambient noise levels in the Beaufort and Chukchi seas can vary dramatically between seasons and sea-ice conditions. The presence of ice also impacts which marine species are present, another factor that influences ambient noise levels.

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

III.A.7.b Sound Propagation.

Underwater sound essentially is the transmission of energy via compression and rarefaction of particles in the conducting medium (i.e., in this case, seawater). The pressure pulse from a sound source propagates outwards in an expanding spherical shell at approximately 1,500 meters per second (m/s) (in seawater). As the shell expands, the energy contained within it is dispersed across an ever-increasing surface area, and the energy per unit area decreases in proportion to the square of the distance traveled from the source.

However, sound propagation is made significantly more complex as a result of sound interaction with acoustically "hard" boundaries such as the water surface and the sea bottom and "soft" internal features like thermal gradients.

Properties of sound that influence how far that sound is transmitted, what species hear it, and what physical and behavioral effects it can have include: its amplitude, frequency, wavelength, directivity (beam pattern) and duration; distance between the sound source and the animal; whether the sound source is moving or stationary; the level and type of background noise; and the auditory and behavioral sensitivity of the species (Richardson et al., 1995a). The frequency of the sound usually is measured in Hertz, pressure level in microPascals (Gausland, 1998), and intensity levels in decibels (Richardson et al., 1995a; McCauley et al., 2000). McCauley et al. (2000) and others (see references in McCauley et al., 2000) express this in terms of its equivalent energy dB re 1 μ Pa². The perceived loudness of any given sound is influenced by many factors, including both the frequency and pressure of the sound (Gausland, 1998), hearing

characteristics of the listener, the level of background noise, and the physical environment through which the sound traveled before reaching the animal.

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

- Sound travels faster and with less attenuation in water than it does in air.
- The fate of sound in water can vary greatly, depending on characteristics of the sound itself, characteristics of the location where it is released, characteristics of the environment through which it travels (Richardson et al., 1995a; McCauley et al., 2000), and the characteristics (for example, depth, orientation) of the receiver (Richardson et al., 1995a; Gausland, 1998).
- Sound propagation can vary seasonally in the same environment.
- Sound propagation varies significantly as a function of sound frequency owing to differential absorption. Low frequencies can travel much further than high frequencies.
- Extrapolation about the likely characteristics of a given type of sound source in a given location within the Chukchi and Beaufort seas based on published studies conducted elsewhere is somewhat speculative, because characteristics of the marine environment such as bathymetry, sound-source depth, and seabed properties greatly impact the propagation of sound horizontally from the source (McCauley et al., 2000; see also Chapter 4 in Richardson et al., 1995a and references provided therein). Richardson et al. (1995a:425) summarized that: "...a site-specific model of sound propagation is needed to predict received sound levels in relation to distance from a noise source." Especially within the Chukchi Sea Planning Area, differences in site characteristics in different parts of the planning area make predictions about sound propagation relatively difficult.
- Because the air-water interface acts as a good reflector, sound generated underwater generally will not pass to the air (Gausland, 1998).

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

Results from underwater-noise studies can be difficult to evaluate and compare, as decibel levels may vary by 10 dB or more between the different units of measure. Sound pressure of continuous sound sources normally is parameterized by an rms measure, while transient sound normally is given in peak pressure measures.

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

III.A.7.c. Seismic Sound.

The oil and gas industry in Alaska conducts marine geophysical surveys in the summer and fall, and on-ice seismic surveys in the winter, to locate geological structures potentially capable of containing petroleum accumulations. These surveys use individual airguns or a combination of individual airguns called an airgun array to produce sound waves that typically are aimed directly at the seafloor. The sound is created

by the venting of high-pressure air from the airguns into the water column and the subsequent production of an air-filled cavity (a bubble) that expands and contracts, creating sound with each oscillation. Airgun output usually is specified in terms of zero-to-peak or peak-to-peak levels. Airgun sizes are quoted as chamber volumes in cubic inches, and individual guns may vary in size from a few tens to a few hundreds of cubic inches. While the seismic airgun pulses are directed towards the ocean bottom, sound propagates horizontally for several kilometers (Greene and Richardson, 1988; Hall et al., 1994). In waters 25-50 m deep, sound produced by airguns can be detected 50-75 km away, and these detection ranges can exceed 100 km in deeper water (Richardson et al., 1995a) and thousands of kilometers in the open ocean (Nieukirk et al., 2004). Typically, an airgun array is towed behind a vessel at 4-8 m depth and is fired every 10-15 seconds. The ship also may be towing long cables with hydrophones (streamers), which detect the reflected sounds from the seafloor.

Airgun-array sizes are quoted as the sum of their individual airgun volumes and again can vary greatly. The array output is determined more by the number of guns than by the total array volume (Fontana, 2003, pers. commun.). For single airguns the zero-peak acoustic output is proportional to the cube root of the volume. As an example, compare two airgun configurations with the same total volume. The first array consists of one airgun with a total volume of 100 cubic inches (in³) resulting in a cube root of 4.64. The second array has the same total volume, but consists of five 20-in³ guns. The second array has an acoustic output nearly three times higher (5 times the cube root of 20 = 13.57) than the single gun, while the gun volumes are equal. The output of a typical two-dimensional/3-dimensional (2D/3D) array has a theoretical point-source output of ~255 dB \pm 3 dB (Barger and Hamblen, 1980; Johnston and Cain, 1981); however, this is not realized in the water column, and maximum real pressure is more on the order of 232 dB \pm 3 dB and typically only occurs within 1-2 m of the airguns.

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

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

Seismic sounds vary, but a typical 2D/3D seismic survey with multiple guns would emit energy at about 10-120 Hz, and pulses can contain significant energy up to at least 500-1,000 Hz (Richardson et al. 1995a). Goold and Fish (1998) recorded a pulse range of 200 Hz-22 kHz from a 2D survey using a 2,120-in³ array.

Richardson et al. (1995a) summarized that typical signals associated with vibroseis sound source used for on-ice seismic survey sweep from 10-70 Hz, but harmonics extend to about 1.5 kHz (Richardson et al., 1995a). In this activity, hydraulically driven pads mounted beneath a line of trucks are used to vibrate, and thereby energize the ice. Noise incidental to the activity is introduced by the vehicles associated with this activity.

Safety Radii for Marine Mammals. Exclusion zones are traditionally established around a seismic-survey operation to help prevent potential harm to marine mammals that are exposed to the acoustic sound sources. Typically, lower output systems produce smaller exclusion zones. The exclusion zone radii around an airgun array vary with water depth. Tolstoy et al. (2004) provide both predicted and measured values for a variety of airgun configurations ranging from 2-20 airguns. Recent National Marine Fisheries Service (NMFS) incidental harassment authorizations (IHA's) (e.g., Lamont-Doherty in 2005 [70 FR

13466-13479]; University of Alaska, 2005) used the data from Tolstoy et al. (2004) to estimate exclusion zones for shallow (<100 m), intermediate, (100-1,000 m), and deep (greater than [$>$] 1,000 m) waters, depending on the type of airgun configuration used. No measurements were made for intermediate-depth waters. The NMFS currently estimates these exclusion zones using a 1.5x correction factor from deepwater data.

The MMPA has established two levels of harassment for marine mammals: Level A and Level B. Simplified, Level A harassment has the potential to injure a marine mammal, while Level B harassment is a disturbance impact. NMFS has established criteria for Level A harassment for nonexplosive sounds at 180 dB re 1 μ Pa rms for cetaceans and 190 dB re 1 μ Pa rms for pinnipeds. A Level B harassment criterion for impulse noises is 160 dB re 1 μ Pa rms. These criteria are then coupled with existing data (e.g., Tolstoy et al., 2004) or field-test data to determine exclusion zones on a case-by case basis based on water depths and airgun configurations.

The 120-dB (rms) isopleth is the approximate zone where marine mammal scientists found in 1998, at 20-km almost total bowhead whale exclusion from a nearshore seismic survey ($P=0.0012$, estimated reduction of 90 % with seismic (Richardson, 1999). Sound level received by bowhead whales in 1998 at 20 km ranged from 117-135 dB re 1 μ Pa rms and 107-126 dB re 1 μ Pa rms at 30 km. At 30-40 km from the shot-point however, sightings were considerably higher than expected, possibly meaning that bowheads were disproportionately displaced into that area as a result of avoiding zones closer to the vessel (Richardson, 1999). Airgun arrays used in 1998 were an 8-gun array totaling 560 in³ and a 16-gun array totaling 1500 in³. The 120-dB (rms) level is the level recommended by the 2001 open-water meeting participants to show where responses by bowhead whales in the Beaufort Sea occurs. An issue complicating the use of the 120-dB isopleth for delimiting the safety zone is that it lies within the reported ambient range of sounds (66-133 dB) in the Arctic marine environment (Burgess and Greene, 1999) and, therefore, depending upon frequency, may be masked by other sound sources, including marine mammal sounds.

III.B. Biological Environment.

III.B.1. Lower Trophic-level Organisms.

Information on lower trophic-level organisms in the northeastern Chukchi Sea was summarized extensively in the EIS's for two previous lease sales (USDOJ, MMS, 1987b, 1990a). They include information on the pelagic community, epontic community, benthic communities, and trophic interactions. The information in two recent Beaufort Sea assessments (USDOJ, MMS, 2003a:Sec III.B.1; USDOJ, MMS, 2004:Sec. IV.B.2.e(3)) also is relevant, because many of the organisms and habitats in the offshore Chukchi Sea are similar to those in the Beaufort Sea. Only a few of the lower trophic species are well known with the possible exception of kelp; most are important only as prey. For example, plankton is consumed by fishes, birds, and the endangered bowhead whales (Secs. III.B.2, III.B.4, and III.B.5); the epibenthic and benthic organisms are consumed by walrus, gray whales, and threatened spectacled eiders (Secs. III.B.4 and III.B.6).

Previous EIS's explain that the Chukchi Sea is part of a Large Marine Ecosystem (LME) with a subarctic climate (Ray and Hayden, 1993). The northern portion of the lease area is similar to other high-arctic regions. Both high-arctic and subarctic portions of the Chukchi Sea are characterized by a short summer, open-water period of growth and then a long winter, ice-covered season. As a result, the net annual growth rates of organisms are slow, resulting in slow recovery to disruption or damage. Several ongoing, broad-scale changes have been observed in lower-trophic level resources, making the Chukchi Sea food web more like the ones in the Northern Bering Sea (Grebmeier and Dunton, 2000; Grebmeier et al., 2006; http://www.arctic.noaa.gov/aro/russian-american/2004_2005/GrebRUSALCA). For example, plankton blooms are now more prolonged, and the relative importance of the benthic activity has changed, as shown in part by changes in the distribution of benthic feeding gray whales. The authors conclude that reductions in the ice cover create the more prolonged plankton blooms, and that the plankton is grazed more efficiently by pelagic consumers such as fish, allowing less to settle to the benthos where it was consumed mainly by marine mammals and seabirds.

The following sections update the information for the northeastern Chukchi Sea. The update is separated into sections on (a) planktonic and epontic organisms, (b) benthic organisms, (c) coastal habitats, and (d) an overall summary.

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

The Chukchi Lease Sale 126 EIS describes the distribution and production of phytoplankton in the eastern Chukchi Sea. It explains that water masses moving northward through the Bering Strait and into the Chukchi Sea transport not only nutrients and phytoplankton, but also zooplankton from the Bering Sea (USDOI, MMS, 1990a:III-11 and Fig. III-B-1a).

There is extensive new information on the distribution of phytoplankton chlorophyll because of the availability of satellite chlorophyll data since 1997. The satellite sensors measure the distribution and concentration of chlorophyll, or the “greenness” of the surface water. Figure III.B-1 illustrates the average concentration of chlorophyll during August for the years 1998 through 2005. It shows the very high concentrations of phytoplankton chlorophyll (i.e., a bloom or biological “hot spot”) in the southwestern Chukchi Sea near the Bering Strait and along the eastern Russian coast during August. The influence of the rich Bering Sea water and a seasonal bloom near the retreating ice edge are noted by Wang, Cota, and Comiso (2004), who analyzed many similar images during a detailed study of phytoplankton variability in the Beaufort and Chukchi seas. Figure III.B.1 also illustrates high concentrations of chlorophyll around Point Hope and Cape Lisburne, and in Ledyard Bay. The images show moderate concentrations in the northeastern Chukchi Sea along the northwestern Alaskan coast. The concentration in the offshore waters of the sale area, including the new northern area, is relatively uniform and generally low, about one-fifth of the concentration along the coast.

A different distribution of chlorophyll is described by Dunton et al. (2005). They synthesized old measurements of chlorophyll, mainly from late-summer icebreaker cruises during the 1980’s and 1990’s for the MMS and National Oceanic and Atmospheric Administration (NOAA) OCS Environmental Assessment Program. They standardized the measurements and integrated them for the whole water column. The results indicate that high chlorophyll concentrations occurred in the water across the northern Chukchi Sea (Dunton et al., 2005:Fig. 4). The results are possibly influenced by the location of ice-edge blooms during the late-summer icebreaker cruises in 1980’s and 1990’s. During the past 10 years, the late-summer ice edge has been located farther north (Comiso, 2005); the location of late summer ice-edge blooms presumably also would be located farther north. The area of high primary production illustrated by Dunton et al. might not be a permanent “hot spot” biologically within the proposed sale area.

Regarding epontic communities, their production is related primarily to under-ice light levels. Previous studies in offshore ice have shown that those levels are related to the thickness of the ice and snow cover. Chlorophyll a measurements under thick multi-year ice showed that the concentrations were about two orders of magnitude less than the concentration under first-year ice (Gradinger et al., 2005). A similar study by Gradinger and Bluhm (2005) examined the influence of sediment concentrations in first-year ice. They found that the spring ice bloom remained up to two orders of magnitude lower in sea ice with a high sediment load. The studies indicate that the epontic production under offshore pack ice in the Chukchi Sea, which would be relatively thick but sediment free, would be relatively high.

The ecological importance of epontic communities would be related partly to the persistence of their substrate—the ice cover. A study of the Chukchi Sea ice cover indicates that the summer melt season has increased slightly (Belchansky and Douglas, 2002). They concluded that the mean annual melt duration increased 2-3 weeks since 1989 in the Chukchi Sea. The longer duration of the melt season, especially during the spring, might have changed slightly the ecological importance of the epontic community as opposed to the pelagic one. (Refer also to the study of epontic communities under offshore opaque pack ice in the Beaufort Sea [Gradinger et al., 2005]), which would indicate the abundance of epontic organisms under multiyear ice in the proposed sale area.)

The MMS’ significance criteria for assessments of species are based primarily on generation times, e.g., a significant effect is one that would affect three or more generations. Because of the criteria, information on generation times, lifespans, and doubling times are important. The doubling time for a phytoplankton population in the surface layer is very short, even in the Arctic. For example, phytoplankton intrinsic

growth rates up to 0.4/day (i.e., doubling time of less than a few days) were measured by Sherr et al. during a recent Shelf Basin Interaction study at Point Barrow (<http://bioloc.coas.oregonstate.edu/SherrLab/SBIresults.html>). Further, the lag between a phytoplankton bloom and the retreating edge of the sea ice usually is only 2-3 weeks (Wang, Cota, and Comiso, 2004). In contrast to phytoplankton, most arctic zooplanktonic organisms reproduce once during the year (Gislason, 2003). For example, the copepod *Calanus finmarchicus* reproduces in May in the surface layers at the time of the spring bloom; therefore, the generation length of arctic zooplanktonic organisms is approximately 1 year.

III.B.1.b. Benthic Organisms.

The Chukchi Sea Lease Sale 126 EIS explains that the benthos in the northeast Chukchi Sea contains components of both the Bering Sea and Beaufort Sea biota (USDOJ, MMS, 1990a:III-13, Table III-B-1, and Fig. III-B-1d). The EIS explains also that the area around the Burger Prospect is inhabited by the following group of species: the polychaete *Maldane*, the brittle star *Ophiura*, the sipunculid (peanut worm) *Golfingia*, and the bivalve *Astarte*. However, a recent study found that brittle stars were overwhelmingly dominant in some parts of the northeastern Chukchi Sea (Ambrose et al., 2001).

The distribution of the fauna is related partly to the sediment type. In offshore areas near the Burger Prospect, the sediment is muddy sand or gravelly mud (Naidu, 2005). The distribution of infauna and epifauna mollusks was related particularly to the percentage of sand and pebbles, respectively (Feder et al., 1994). They concluded also that the abundance and biomass of snails and other epifaunal mollusks around the Burger prospect to the south of Hanna Shoal is relatively low compared to the mollusks near the Alaskan coast (Fig. III.B-2). In contrast, amphipods are relatively abundant in areas with pebbly sand between Point Franklin and Wainwright (USDOJ, MMS, 1990a:Fig. III-B-1d). The sediment is muddy in Ledyard Bay, where eider ducks feed on epibenthic organisms like amphipods (Sec. III.B.5) (Naidu, 2005); and along other parts of the coast it is muddy sand or gravelly muddy sand.

Sidescan-sonar surveys have detected feeding traces from gray whales in water over about 50 m deep with fine sand and mud, and traces of walrus feeding in other areas (USDOJ, MMS, 1990a:III-15 and Sec. III.B.1.c(3)). The seafloor marks, the sediment types, and the presence of soft-bodied benthic organisms, such as worms, indicate that the most of the surface sediment in the proposed sale area is unconsolidated.

The Beaufort Sea multiple-sale EIS explains that a special benthic community is the Boulder kelp community (USDOJ, MMS, 2003a). Similar kelp communities in the Chukchi Sea are located only inshore of the proposed sale area, as explained in Sec. III.B.1.c.

As attested to in the acoustic profiles of MacDonald et al. (2005) and Pauli et al. (2007), "pockmarks" may exist in the northeast of the Chukchi Sea sale area and the nearshore eastern Beaufort Sea shelf. The age of these features, whether they are associated with methane seeps, whether they support biological communities, and whether there are any such features within the proposed sale area are all unknown. Upon review of this information, we have determined that the existence of these features and any associated communities within the proposed action area is highly speculative and the related discussions have been dropped from the final EIS.

The Chukchi Sea benthos generally is richer than that on other arctic shelves (Grebmeier and Dunton, 2002; Dunton et al., 2005). The benthic faunal biomass is relatively high in northeastern Chukchi, compared to central and western Chukchi and compared to the rest of the arctic seas (Grebmeier and Dunton, 2000:Fig. 1). Grebmeier and Dunton (2000) explain that the richness probably is due partly to the inability of Chukchi fauna to consume all of the primary production, thereby allowing a lot of organic matter to sink to the seafloor. They refer to the situation as weak or loose trophic "coupling", and the Arctic Climate Impact Assessment (ACIA) refers to such loose coupling as "mismatch" between trophic levels (ACIA, 2005:Sec. 9.3.2.2). The ongoing research by Grebmeier et al. on Russian-American Long-term Census of the Arctic (RUSALCA) cruises on both sides of the Chukchi Sea has detected areas with high benthic biomass, such as the southcentral portion, but no areas with special benthic communities. Regardless, because of the relatively large amount of organic matter that sinks to the seafloor in the Chukchi Sea, there are many areas which are important to benthic grazers such as ducks, walrus, and gray whales (Grebmeier and Dunton, 2000).

The concentration of heavy metals in the sediments and benthic organisms from the Chukchi and Beaufort seas has been the subject of two recent studies. Naidu (2005) reviewed samples that were collected during the 1990's after operation of the Red Dog Mine in the southeastern Chukchi Sea. He concluded that the trace-metal concentrations in the sediments there and from the northeastern Chukchi Sea were low, and that the environment was "pristine". Stern and Macdonald (2005) determined the concentration of total and methyl mercury (HgT and CH₃Hg) in a common *Calanus* copepod and other organisms that were collected during the late 1990's. They concluded that the background concentrations of HgT were low in samples from the Chukchi Plateau, and that the concentrations in samples from the Canadian Basin were about twofold higher. They related the relatively high concentrations in the Canadian Basin to the input from land and spring melt. The concentrations in the Chukchi Sea are similar to those that have been observed in the Beaufort Sea (USDOI, MMS, 2003a:Sec. III.A.5.a(2)). An important aspect for the present assessment is that both sets of the above "pristine" Chukchi samples were collected after the discharge of drilling fluids during the exploratory drilling in 1989, 1990 and 1991.

The recovery time for benthic communities is indicated by a study of ice gouges (Conlan and Kvitek, 2005). They studied the recolonization of ice gouges in relatively shallow water (12-28 m) in the Canadian high Arctic. They found that new scours were recolonized quickly by some animals, such as polychaetes, but predicted that recolonization of the original community would require many years. Two ice scours that they studied for 8 or 9 years achieved only 65-84% recolonization of the original community within that time. The fastest recolonization rate (65% in 8 years) might be appropriate for the slightly deeper but warmer northeastern Chukchi Sea. The general recolonization rate that will be used for subsequent assessment of the persistence of pipeline-burial effects is about three-quarters of the community within a decade.

III.B.1.c. Coastal Habitats.

The Chukchi Sea Lease Sale 126 EIS summarizes the information on habitats along the Alaskan coast (USDOI, MMS, 1990a). Sea ice dominates the Chukchi Sea coastal habitats, as noted also for the Beaufort Sea coastal habitats (USDOI, MMS, 2003a:III-30) and for Arctic Ocean coastal habitats in general (Gutt, 2001). Due to the thick ice cover, the shallow benthos and coastline are highly disturbed during the winter and are, therefore, not inhabited year-round by large organisms.

The Sale 126 EIS describes the well-known kelp community in the center of Peard Bay (USDOI, MMS, 1990a:III-13 and IV-C-14). Information on the kelp community is summarized also in the recent Programmatic EA (PEA) for 2006 seismic exploration (USDOI, MMS, 2006a). There is no new information on the kelp community, so the previous descriptions are incorporated by reference. The descriptions do not specify the areal extent of the kelp within the bay, but that EIS does explain (USDOI, MMS, 1990a:III-15) that bivalves and polychaetes were dominant in the deeper, central section of Peard Bay. Therefore, the extent of the kelp bed in Peard Bay might be limited to just part of the bay.

The 126 EIS and PEA explain that there is kelp also along the coast near Skull Cliffs, about 20 km to the northeast of Peard Bay, and along the coast about 25 km southwest of Wainwright in water depths of 11-13 m. The EIS also explains that the spatial extent, which has not been examined closely, probably is limited by the presence of rock and other hard substrate. All three kelp communities are close to the coast; they are located outside of the proposed sale area but within the area through which an oil pipeline might be constructed. We are aware of no new information on the distribution of kelp near the proposed sale area, but there is additional information on the recovery of kelp after disturbance. Previous studies had shown that when kelp was removed experimentally from boulders in the Beaufort Sea, only 50% of the denuded area was recolonized within 3 years. The study concluded that grazing by invertebrates might be a reason for the limited recolonization. Recently, recolonization rates were measured for kelp within cages that excluded invertebrates (Konar, 2007). However, even within the cages, there was no recruitment within 2 years, demonstrating again that kelp recovers very slowly from disturbance.

The general characteristics of the Chukchi coastline were determined for Sale 109, and those characteristics were incorporated in the Sale 126 EIS. The characteristics included four basic categories, depending on the substrate and vegetation (USDOI, MMS, 1987b:Fig. IV-13). During 2001, MMS contracted for a reexamination of the shoreline characteristics from Point Barrow to Point Hope (USDOI, MMS, 2003a). The new classification system, which distinguishes 10 basic categories and 5 subcategories, is consistent

with the results of the previous system, listing the most sensitive parts of the coastline as the lagoons adjacent to the proposed sale area.

III.B.1.d. Summary.

As a summary of the information above, lower trophic-level organisms were described very well in previous EIS's. The recent data on plankton and epontic organisms is consistent with the information in the Chukchi Sea Lease Sale 126 EIS. The recent data further indicates that production probably is high within the proposed sale area during the early summer retreat of the ice edge and that during midsummer, the production generally is low and relatively uniform within the proposed sale area. The data also indicate that there is higher production near the Bering Strait and along the Russian Chukotka coast, around Point Hope and Cape Lisburne, and along the Alaskan coast, including Ledyard Bay. The length of the melt season is 2-3 weeks longer than it was in the late 1980's. The generation times of Chukchi phytoplanktonic and zooplanktonic organisms are a few days and a year, respectively.

The benthos in the Chukchi Sea is relatively rich. The richness and the presence of feeding marks on the seafloor from walrus and gray whales indicate that the benthos supports abundant consumers. The sediment is partly muddy sand or gravelly mud; i.e., an unconsolidated type of sediment. When the natural benthic community is disturbed by ice scour, only about two-thirds of the community probably would recolonize the gouge within 8 years. The background concentration of total mercury and methyl mercury is low in zooplankton from the Chukchi, indicating that the Chukchi is relatively pristine. Pockmarks have been observed on deep Chukchi slope; the pockmarks may be an indication of methane seeps and cold-seep communities of organisms.

The coastal habitats include kelp communities in Peard Bay, near Skull Cliffs about 20 km northeast of Peard Bay, and along the coast about 25 km to the southwest of Wainwright. The sensitive parts of the coastline include the lagoons.

III.B.2. Fish Resources.

The proposed lease sale could affect freshwater and offshore marine habitats. This section focuses more on coastal and marine fish/fishery resources and habitats occurring in nearshore and offshore waters of the Chukchi Sea, because most impacts would occur in these areas, but freshwater habitats also are important. There are few species covered by fishery-management plans in these waters. The issue of aquatic invasive species is directly pertinent to the conservation and management of fishery resources. Relevant terms and regulatory background concerning aquatic invasive species is discussed in Section II.B.5.b. Presently, the five species of Pacific salmon occurring in Alaska are the only managed species with essential fish habitat (EFH) designated in the Alaskan Chukchi Sea. Essential fish habitat is described in Section III.B.3.

III.B.2.a. Major Surveys of Coastal and Marine Fish Resources and Habitats.

This section briefly reviews some important surveys conducted in these waters in the last century.

Walters (1955) briefly summarized the history of arctic Alaska ichthyology to date. He wrote: "The ichthyofauna of western Arctic America has been studied the least of any major sector of the northern polar regions, and that of Arctic Alaska the least of any equally great area of North America" (Walters, 1955). Fifty years later, Walters' comment remains, for the most part, accurate.

The first major scientific collections of fishes in the Chukchi Sea were those made by the Russians A.P. Andriyashev, K.I. Panin, and P.V. Ushakov in 1932 and 1933 (Raymond, 1987). Andriyashev (1955; a translation of a report published in 1937) described basic information concerning fishes collected by Russian expeditions of the Bering and Chukchi seas.

Frost and Lowry (1983) reported on thirty-five successful otter-trawl tows that were conducted in the northeastern Chukchi and western Beaufort seas in August-September of 1976 and 1977. In 1976, two tows were made in the western Beaufort Sea in water 40 m and 123 m deep. In 1977 (August 2-September 3), 33 tows were made in the northeastern Chukchi and western Beaufort seas in waters 40-400 m deep. Many were conducted near the southern edge of pack ice. Frost and Lowry (1983) caught 133 fishes

belonging to 14 species in trawls made in 1976. In the more extensive trawls conducted in 1977, they caught 512 fishes belonging to 17 species. A total of 19 species or species groups of fishes were identified from the combined tows.

Fechhelm et al. (1984) reported results of an ichthyological survey conducted in 1983 that focused primarily on arctic fish usage of and ecological dependence on marine estuarine environments along the northeastern Chukchi Sea coast from Peard Bay to Point Hope. Data were collected for the most part during the open-water, summer season and, to a lesser extent, in winter. Their survey revealed the most prominent species encountered during 1983 were arctic cod, arctic staghorn sculpin, fourhorn sculpin, capelin, shorthorn sculpin, hamecon, arctic flounder, and saffron cod. Fourhorn sculpin and arctic flounder occurred in nearshore waters (<1 km), while the remaining sculpins were found exclusively in deeper, offshore (>1 km) waters. Arctic and saffron cod were found to occupy both nearshore and offshore waters.

Barber, Smith, and Weingartner (1994) reported data obtained in the northeastern Chukchi Sea between Cape Lisburne in the south to the ice edge in the north between 1989 and 1992. These surveys (1989-1992) are the most recent fish surveys conducted within the proposed lease sale area. Collectively, these surveys and associated studies reflect a sparse sampling of fish resources across the northeastern Chukchi Sea. Sampling effort has been spatially and temporally irregular and disjunct. Coastal waters of the western Beaufort Sea are better sampled than coastal waters of the northeastern Chukchi Sea.

In summer 2004, a RUSALCA expedition was conducted in the Bering and Chukchi seas (Mecklenburg et al., 2005). The primary study area lay between Wrangel Island and Herald Canyon in Russia Federation territorial waters to Cape Lisburne, Alaska to Point Barrow, Alaska and south to the Bering Strait. Most of sampling sites lie to the south and west of the Chukchi Sea sale area; however, three sampling sites occur on the southern margins of the sale area (off Cape Lisburne).

Fish biologists on the RUSALCA expedition noted the following qualitative conclusions: (1) the Chukchi benthic community is highly diverse and patchy; and (2) both fish abundance and diversity seem lower in the Chukchi Sea than in the Bering Sea. The largest catches occurred to the south, and were usually at least one order of magnitude higher than those in the north. Also, biologists noted several range extensions or rare species.

Surveys often have been directed at one fish assemblage (e.g., subadult and adult demersal fishes) and, consequently, did not sample for other fish assemblages (pelagic life stages and species). Information from many surveys was reported only for abundant species, and that information was not standardized. Surveys of coastal and marine fish resources in the Chukchi and Beaufort seas are typically conducted during periods that ice cover is greatly reduced (late July, August, or September) and information concerning the distribution, abundance, habitat use, etc., of marine fishes outside this period is limited. Due to the lack of specific information for many species, it is necessary to discuss the biology and ecology at the family level. Generalized life-history strategies of the families with fish species known to be occurring in the region (see USDOJ, MMS, 2006a:Appendix B). Most of this information was taken from Mecklenburg, Mecklenburg, and Thorsteinson (2002).

Despite these previous works, several data deficiencies remain. Information of current distribution and abundance (e.g., fish per square kilometer) estimates, age structure, population trends, or habitat use areas are not available for fish populations in the northeastern Chukchi Sea. Many fish studies reporting distribution and/or abundance are 20-30 years old. Other studies are still older. For example, the only survey of demersal fishes in the region is more than 20 years old. Fish assemblages and populations in other marine ecosystems of Alaska (e.g., Gulf of Alaska, Bering Sea) have undergone observable shifts in diversity, distribution, and abundance during the last 20-30 years; it is not known if the findings of Frost and Lowry (1983) still accurately portray the diversity and abundance of demersal fishes in the Alaskan Beaufort Sea. The same is true for other dated studies. It is possible that they no longer accurately and precisely reflect the current distribution, abundance, and habitat use patterns of fish resources in the northeastern Chukchi and western Beaufort seas. Such information could be stale, or in some cases, stagnant. If so, accurate information concerning the distribution, abundance, and habitat use patterns of fish resources is incomplete and/or unavailable from which to accurately and/or precisely assess environmental impacts from the Proposed Action.

Another important data gap is the lack of information concerning discrete populations for arctic fishes. The literature abounds with casual references made of various fish populations without having delimited the population other than by perhaps using arbitrary boundaries of a study area, or presenting data without discriminating one discrete population unit from another. Additionally, a few marine species are regarded as widespread and/or abundant, yet distribution and density statistics for discrete populations are scarce, unknown, and therefore, incomplete. Several species are known only from a single specimen of each species; others are known from perhaps a handful of specimens collected years to decades ago. Population information is entirely lacking for such species.

III.B.2.b. Fish Resources of Arctic Alaska and Their Ecology.

Three large marine ecosystems (LME's) encompass coastal and offshore waters of arctic Alaska. They are the Bering Sea, Chukchi Sea, and the Beaufort Sea. Each LME is characterized by distinct hydrographic regimes, submarine topographies, productivity, and trophically dependent populations, yet influences the others. The Chukchi Sea LME represents a transition zone between the fish assemblages of the Beaufort and Bering LME's. Aspects of all three LME's are discussed below because they influence each other and to portray the importance of the Chukchi Sea from a broad perspective.

The Alaskan Chukchi and western Beaufort Seas support at least 98 fish species; representing 23 families (Table III.B-1) have been documented to occur (Mecklenburg, Mecklenburg, and Thorsteinson, 2002). These families include lampreys, sleeper sharks, dogfish sharks, herrings, smelts, whitefishes, trouts and salmon, lanternfishes, cods, sticklebacks, greenlings, sculpins, sailfin sculpins, fathead sculpins, poachers, lumpsuckers, snailfishes, eelpouts, pricklebacks, gunnels, wolffishes, sand lances, and righteye flounders. Forty-nine species are common to both large marine ecosystems. Additional species are likely to be found in the Chukchi Sea if and when coastal and offshore waters are more thoroughly surveyed.

Aquatic systems of the Arctic undergo extended seasonal periods of frigid and harsh environmental conditions; therefore, fish inhabiting such systems must be biologically and ecologically adapted to surviving such conditions so as to produce offspring that eventually do the same. Behavioral strategies of each life stage are evolutionarily timed to coincide with environmental conditions favoring survival to the next life stage. The process of natural selection does not favor individuals or populations that are not adapted to survive such conditions. Important environmental factors that arctic fishes must contend with include reduced light, seasonal darkness, prolonged low temperatures and ice cover, depauperate fauna and flora, and low seasonal productivity (see McAllister, 1975 for a description of environmental factors relative to arctic fishes).

The lack of sunlight and extensive ice cover in arctic latitudes during winter months influence primary and secondary productivity, making food resources very scarce during this time, and most of a fish's yearly food supply must be acquired during the brief arctic summer (Craig, 1989). There are fewer fish species inhabiting Arctic waters of Alaska as compared to those inhabiting warmer regions of the State. The Chukchi Sea is warmer, more productive, and also supports a more diverse fish fauna than occurs in the western Beaufort Sea (Craig, 1984, citing Morris, 1981; Craig and Skvorc, 1982; Craig 1984). Also, most fish species inhabiting the frigid polar waters are thought to grow and mature more slowly relative to individuals or species inhabiting boreal, temperate, or tropical systems.

Marine waters of the Chukchi and Beaufort seas offer the greatest two- and three-dimensional area for arctic fishes to exploit; these include neritic waters and substrates (occurring landward of the continental shelf break, as delimited by the 200-m isobath) and oceanic waters and substrates (occurring seaward of the continental shelf break [>200 -m isobath]). The diverse fishes of the eastern Chukchi and western Beaufort seas use a range of waters and substrates for spawning, breeding, feeding, or growing to maturity (Table III.B-2).

Arctic fishes of Alaska are classified into primary assemblages by occurrence in basic aquatic systems and by life-history strategies that allow the fishes to survive the frigid polar conditions (Craig, 1984; Craig, 1989; Moulton and George, 2000; Gallaway and Fechhelm, 2000). A life-history strategy is a set of co-adapted traits designed by natural selection to solve particular ecological problems (Craig, 1989, citing Stearns, 1976).

III.B.2.b(1) Primary Fish Assemblages.

The primary assemblages of arctic fishes are:

- freshwater fishes that spend their entire life in freshwater systems (although some also might spend brief periods in nearshore brackish waters);
- marine fishes that spend their entire life in marine waters (some also spend brief periods in nearshore brackish waters along the coast); and
- diadromous and anadromous fishes that move between and are able to use fresh, brackish, and/or marine waters due to various biological stimuli or ecological factors.

While some arctic fish species are described in the scientific literature and in surveys as being abundant in the region, they are only so in a relative context and are of low overall abundance.

Species having low abundance and/or small ranges occurring in the first quartile of the frequency distribution of species abundances or range sizes (i.e., 25%; the quartile definition from Gaston, 1994) are termed “rare” (Gaston, 1994). The terms “common” and “widespread” are used as an antithesis of “rare” (Gaston, 1994). Rare as used in this sense does not imply protected status under the law, such as under the Endangered Species Act.

Marine waters support the most diverse, although least well known, fishes of the Alaskan Beaufort Sea region. Studies of marine fishes in the region are very limited; most of the surveys/studies have been performed in coastal waters landward of the 200-m isobath, with scant surveys having sampled deeper waters (for example, Frost and Lowry, 1983; Jarvela and Thorsteinson, 1999). In areas where coastal surveys have been conducted, seasonal trends in relative abundance of dominant (abundant) fish species are evident (Jarvela and Thorsteinson, 1999). However, robust population estimates or trends for marine fishes of the region are unavailable. Distribution or abundance data for marine fish species are known only generally at the coarsest grain of resolution (for example, common, uncommon, rare), although a few studies include abundance estimates (qualitative or quantitative) for localized areas (Frost and Lowry, 1983; Griffiths et al., 1998; Jarvela and Thorsteinson, 1999). Detailed information generally is lacking concerning the spread, density, or patchiness of their distribution in the overall Chukchi Sea region. Data concerning habitat-related densities; growth, reproduction, or survival rates within regional or local habitats; or productivity rates by habitat, essentially are unknown for fishes inhabiting waters seaward of the nearshore, brackish-water ecotone.

Frost and Lowry (1983) reported anatomical, reproductive, and prey statistics for selected species sampled (arctic cod, polar eelpout, twohorn sculpin, hamecon, arctic alligatorfish, leatherfin lumpsucker, fish doctor, and spatulate sculpin) from 35 otter-trawl tows performed in the northeastern Chukchi and western Beaufort seas in August-September 1976 and 1977. Prey of the summarized species as a group consists of copepods, amphipods, isopods, mysids, euphasiids, polychaete worms, cumaceans, caprellids, shrimp, brittle stars, and arctic cod. Nineteen species of fishes were identified; three species (arctic cod, polar eelpout, and twohorn sculpin) accounted for 65% of all fishes caught.

Marine fishes prefer the colder, more saline coastal water seaward of the nearshore brackish-water zone. 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 nearshore brackish waters with diadromous fishes, primarily to feed on the abundant epibenthic fauna or to spawn (Craig, 1984). In the fall, when diadromous fishes have moved out of the coastal area and into freshwater systems to spawn and overwinter, marine fishes remain in the nearshore area to feed.

Marine fishes in the region primarily feed on marine invertebrates and/or fish. They rely heavily on epibenthic and planktonic crustacea such as amphipods, mysids, isopods, and copepods. Because the feeding habits of marine fishes in nearshore waters are similar to those of diadromous fishes, some marine fishes are believed to compete with diadromous fishes for the same prey resources (Craig, 1984; Fechtel et al., 1996). Competition is most likely to occur in the nearshore brackish water ecotone, particularly in or near the river deltas. As nearshore ice thickens in winter, marine fishes probably continue to feed under the ice but eventually depart the area as ice freezes to the bottom some 2 m (6 ft) thick. Seaward of the bottomfast ice, marine fishes continue to feed and reproduce in coastal waters all winter (Craig, 1984).

Many evidently spawn during winter, some in shallow coastal waters, and others in deeper waters. Arctic cod spawn under the ice between November and February (Craig and Halderson, 1981). Snailfishes spawn farther offshore by attaching their adhesive eggs to a rock or kelp substrate.

III.B.2.b(2) Secondary Marine Fish Assemblages. To better understand fish resources and the potential impacts of disturbances to their populations and habitats, we further refined the scale of primary fish assemblages into secondary (ecological) assemblages based on fish behavior and ecology, and general oceanographic/landscape features, such as the continental shelf break or polar ice (Table III.B-2). The purpose of characterizing finer scale hierarchical organization of arctic fishes is to enhance our analysis of potential impacts in a data-deficient setting, particularly concerning marine fishes. Many species overlap to some degree in these assemblages, due in part to the different habitat areas used by different lifestages (e.g., arctic cod occur in both neritic (<200 m depth)-demersal [as adults] and cryopelagic [as juveniles] assemblages).

Based on the general ecology and three-dimensional occurrence of marine fishes in the sea, we identified the following secondary marine fish assemblages: neritic-demersal, neritic-pelagic, oceanic-demersal, and oceanic-pelagic. An additional and important assemblage that is unique to polar regions is the cryopelagic fish assemblage. Distribution, abundance, life-history statistics, and trophic data for fishes are listed in Table III.B-2. Following are characterizations of each secondary fish assemblage.

III.B.2.b(2)(a) The Neritic-Demersal Assemblage. The neritic-demersal assemblage is comprised of marine fishes living at or near the seafloor of the continental shelf (landward of the 200-m isobath) and capable of active swimming. Studies of species other than those seasonally using the nearshore brackish ecotone are scarce. Some uncommon or rare species of this assemblage include the toothed cod, whitespotted greenling, spinyhook sculpin, veteran poacher, leatherfin lump sucker, kelp snailfish, fish doctor, and Alaska plaice. Species of this assemblage that are attributed as being widespread and/or abundant include the fourhorn sculpin, twohorn sculpin, polar eelpout, and arctic flounder. Life-history data for many of the demersal species using neritic substrates is lacking (e.g., whitespotted greenling, twohorn sculpin, spinyhook sculpin, veteran poacher); consequently, assessing the species resilience to perturbations is not feasible until additional information becomes available.

III.B.2.b(2)(b) The Neritic-Pelagic Assemblage. Fishes inhabiting the water column over the continental shelf (landward of the 200-m isobath) comprise the neritic-pelagic assemblage. Some fishes of this assemblage are prone to occupying the upper water column (pelagic species), while others exhibit greater use of the lower depths or the entire water column and seafloor (benthopelagic species). Surveys and studies of pelagic fishes inhabiting “offshore waters” (as defined by Jarvela and Thorsteinson [1999] as marine waters deeper than 2 m), especially those more than 30 m in depth, are scant. Species of this assemblage regarded as widespread or abundant include the Pacific herring, arctic cod, capelin, and Pacific sand lance. Two benthopelagic species are uncommon (fourline snakeblenny and slender eelblenny); the polar cod is regarded as rare. No species of this assemblage are assessed as being of low resilience, because life-history data are lacking.

III.B.2.b(2)(c) The Cryopelagic Assemblage. The term “cryopelagic” is used to describe fishes that actively swim in neritic or oceanic waters but, during their life cycle, are associated in some way or other with drifting or fast ice. The cryopelagic fish assemblage is further described by Andriashev (1970) as such:

Both young and adult fishes can be associated with ice or water immediately below the ice. These relationships are usually trophic in nature, but in some cases ice provides fishes with a shelter from predators or even a substratum for sucking. The association of fishes with ice can be observed easily and often. The more intimate aspects of their behavior are, however, still little known....

Andriashev (1970) described what may be the first known cryopelagic fish species, the arctic cod (*Boreogadus saida*; previously known as polar cod), stating:

According to many eyewitness observations, arctic cod often occur in ice holes, cracks, hollows and cavities in the lower surface of the ice. They are most common among broken ice or near the ice edge. Here, as the ice thaws and breaks up phyto- and zooplankton develop and provide food

for arctic cod. It is possible that the fish also feed on organisms of the amphipod-diatom ice community inhabiting the lower “fluffy” ice layer. This peculiar ice biocoenosis is known now from both the Arctic and Antarctic. At the same time polar cod apparently use sea ice as shelter from the numerous enemies attacking them from both water and air.

Andriashev (1970) described the arctic cod as:

...one of the main consumers of Arctic plankton;...it is a common food of Greenland seal (*Pagohoca groenlandica*), ringed seal (*Phoca hispida*), bearded seal (*Erignathus barbatus*), white whale (*Delphinapterus leucas*), narwhal (*Monodon monoceros*) and other marine mammals, many marine birds (including gulls, guillemots, etc.) and fishes (citing Klumov, 1937, Andriashev, 1954).

The arctic cod is abundant in the region and their enormous autumn-winter pre-spawning swarms are well known. The species is also very widely distributed and they make distant migrations, not only along the shelf areas in the Arctic Basin but also in higher latitudes.

In addition to the arctic cod, other cryopelagic fishes of the Alaskan arctic region include polar cod, toothed cod, and Pacific sand lance. Arctic cod and Pacific sand lance are assumed to be of medium resilience to exploitation; polar cod and toothed cod are data deficient such that an assessment of resilience is not feasible with available information.

III.B.2.b(2)(d) The Oceanic-Pelagic Assemblage. Fishes inhabiting the water column of oceanic waters seaward of the 200 m isobath comprise this assemblage; most species exhibit some preference of bathymetric stratification. Those species chiefly occurring within the upper 200 m of the water column are regarded as epipelagic fishes. Fishes inhabiting oceanic waters between 200 and 1,000 m in depth are termed mesopelagic fishes. Bathypelagic fishes are those species inhabiting depths >1,000 m in depth; as yet, there are no known bathypelagic fishes in the Alaskan Beaufort Sea. Several of the epipelagic species include the Pacific herring, arctic cod, polar cod, and Pacific sand lance (note that several of these species also use neritic and ice-covered waters). The glacier lanternfish is largely a mesopelagic fish; however, it is known to sometimes use the epipelagic zone. Oceanic waters are poorly surveyed; hence, relative abundance estimates of oceanic fishes (demersal or pelagic) in Table III.B-1 are extremely crude. Life-history statistics indicate that the noted species are of medium to high resilience to exploitation; however, population estimates are ambiguous at best in the region, thereby canceling out the resilience assessments.

III.B.2.b(2)(e) The Oceanic-Demersal Assemblage. Fishes living on or close to substrates below oceanic waters are encompassed in the oceanic-demersal assemblage. The ogac, ribbed sculpin, spatulate sculpin, shorthorn sculpin, spinyhook sculpin, archer eelpout, pale eelpout, and daubed shanny are among the fishes included in this assemblage. Life-history statistics for most species covered in this assemblage are data deficient, chiefly for lack of fish surveys and studies in oceanic waters of the Alaskan arctic. For those with suitable life-history data, the Bering flounder and Alaska plaice are assessed as of low resilience to exploitation; the Greenland halibut is of very low resilience to exploitation.

III.B.2.b(2)(f) The Diadromous Fish Assemblage. Diadromous fishes move between and are able to live in fresh, brackish, and/or marine waters due to various biological stimuli or ecological factors. Such fishes demonstrate variations in their uses of fresh, brackish, and/or marine waters, leading biologists to describe these variations with terms such as “anadromous, amphidromous, or diadromous.” Each term requires some form of migration; diadromy involves the migration between marine and fresh waters. However, many marine fishes are migratory but are unable to withstand waters of lower salinity, such as freshwater. Therefore, it is important to distinguish diadromous (migratory) fishes from other migratory fishes. Because various scientists use one term (anadromous, amphidromous, or diadromous) in preference to another for describing such variations, the literature is sometimes inconsistent and vague in the use of these terms. The use of such terms in this section are as used by the cited authors; however, it should be generally understood that they are referring to basically the same assemblage of fishes that we characterize here as diadromous fishes.

Craig (1989) wrote:

The nearshore zone is marked by a series of bays, lagoons, deltaic mudflats, and narrow barrier islands. A biologically important feature of the nearshore zone is the occurrence of relatively warm and brackish water (5-10 C, 10-25 ppt) that frequently lies adjacent to the shoreline in summer (citing Craig, 1984). This estuarine zone extends over much of the length of the coast and is often distinctly different from adjacent marine waters (-1 to 3 C, 27-32 ppt). This nearshore zone provides a transportation corridor for fishes not fully adapted to the marine environment as well as an important feeding habitat for anadromous and marine fishes such as Arctic cisco, least cisco, humpback whitefish, broad whitefish, Arctic char, fourhorn sculpin, and Arctic cod. In winter, the estuarine band is absent, and nearshore waters freeze solid to a depth of about 2 m.

Gallaway and Fechhelm (2000) describe the nearshore ecotone during warmer months as such:

In June, rising air temperatures and increasing periods of solar radiation bring about the spring freshet. Snowmelt increases river discharge, which overflows shorefast ice attached to land in and near river deltas. By mid-July, the nearshore zone of the Beaufort Sea is usually ice-free from the shore to the edge of the pack ice, which by late summer may retreat from 10 to 100 km offshore. River runoff coupled with the melting of coastal ice creates brackish conditions (low to moderate salinities) in nearshore areas, with lower salinities near the mouths of rivers. The relatively warm river discharge, plus increased solar radiation, elevates nearshore water temperatures. As the summer progresses, this nearshore coastal band of warm, brackish water begins to deteriorate as it mixes with the vast sink of cold, arctic marine water. By late summer, rapidly decreasing daylight, decreased river discharge, and the relentless mixing of nearshore with ocean water all contribute to the dissipation of the warm, brackish nearshore band. Nearshore waters remain cold and saline from then until the September freeze that marks the onset of another winter.

The short arctic summer is a period of intense biological activity in coastal waters (Gallaway and Fechhelm, 2000). Nearshore waters are the prime feeding area for North Slope diadromous fishes (Gallaway and Fechhelm, 2000). Most coastal summer feeding studies have identified varying degrees of dietary overlap among the four (most common) diadromous species (Gallaway and Fechhelm, 2000). Broad whitefish chiefly consume amphipods, copepods, polychaetes, and chironomids. Mysids dominate the diets of arctic cisco and least cisco; however, chironomids, amphipods, and copepods also are important prey to these fish species. Dolly Varden feed on mysids, amphipods, and other fishes. Feeding is opportunistic, and the specific prey consumed may vary with concentration (i.e., prey availability) (Gallaway and Fechhelm, 2000).

Most anadromous species vacate Alaskan coastal waters in winter and return to rivers, deltas, and lakes to overwinter (Craig, 1989). Overwintering sites are more than places where fish simply reside during winter. Anadromous salmonids and coregonids are all fall-spawners whose eggs incubate in streambed gravels throughout the winter (Craig, 1989). Spawning must occur in an area where a winter water supply is ensured. Because such areas are scarce, spawning often occurs in or adjacent to the same areas where the fish overwinter.

Craig (1989) also states that the life history patterns of anadromous fishes involve repeated migrations between overwintering sites and coastal waters, followed by a spawning migration into fresh water at maturity. This cycle consists of three broad phases: spawning, freshwater residency (of juveniles), and anadromy (diadromy).

Craig (1989) describes at greater length the life-history characteristics of arctic anadromous fishes. He concludes that arctic anadromous fishes possess the following characteristics:

- Arctic anadromous fishes have long life spans, with maximum ages of 18-25 years for five species described in his monograph (arctic char, arctic cisco, least cisco, broad whitefish, and humpback whitefish). This contrasts markedly with other anadromous salmonids in temperate latitudes whose maximum recorded ages range from 2-12 years.
- The growth rate of arctic (anadromous) fishes declines markedly once sexual maturity is reached, as is common among fish in general because of the energy demands of reproduction (Craig, 1989, citing Roff, 1984; Craig, 1985). Older arctic (anadromous) fish grow only about 1-2 cm each year.

- The ages at which half the members of a population spawn for the first time are 7-8 years for char and ciscoes, and 10-11 years for the whitefishes.
- Arctic anadromous fishes do not die immediately after spawning (as do the five species of Pacific salmon). Some live to spawn again, but the frequency of spawning after maturity is probably variable, with some members of a population spawning annually and others at intervals of two or more years, depending on how well the fish fared nutritionally between spawning periods.

These life-history characteristics imply that recruitment of young arctic anadromous fishes is, on the average, low (Craig, 1989). Craig (1989) suggests mechanisms responsible for a generally low recruitment of young could be several, among which are:

- Food supply probably plays an important role in the recruitment of young. Because reproduction entails a heavy energy demand, mature arctic fish will not spawn if food is insufficient prior to spawning.
- Winter mortality is undoubtedly important in limiting populations, and mortality may be especially high for young fish. If finding a suitable overwintering site is a learned response for the fish rather than a programmed (genetic) response, many young-of-the-year presumably would be unsuccessful in locating a suitable overwintering site during their first winter. The fortunate survivors, however, could return in subsequent winters to the site in which they successfully overwintered. The net result would be a large loss of young each winter.
- Two additional factors that could contribute to reduced number of young are (a) predation and (b) a limited extent of suitable spawning habitat in the Alaskan Beaufort Sea region.

Craig (1989) also notes that populations with similar life history strategies (i.e., long-lived, have low population turnover rates, and have relatively stable numbers of adults) implies something about their population stability. By having many year classes of older, mature fish, they are capable of withstanding an occasional reproductive loss without jeopardizing the survival of the population.

III.B.2.c. Pacific Salmon.

All five species of Pacific salmon occur in the Alaskan Chukchi Sea (Craig and Halderson, 1986; NMFS, 2005); the pink, chum, sockeye, chinook, and coho salmon. A large body of information exists on the life histories and general distribution of salmon in Alaska (NMFS, 2005). Pacific salmon life history, general distribution, fisheries background, relevant trophic information, habitat, and biological associations are described in Appendix F.5 of NMFS (2005) and incorporated herein by reference. More information regarding the biology, ecology, and behavior of Pacific salmon is described in Augerot (2005), Quinn (2005), and the Alaska Department of Fish and Game (ADF&G) Fish Distribution Database-Fish Profiles.

Salmon numbers decrease north of the Bering Strait (Craig and Halderson, 1986). Spawning runs in arctic streams are minor compared to those of commercially important populations farther south (Craig and Halderson, 1986). Rivers south of Point Hope support comparatively large runs of chum and pink salmon (Craig and Halderson, 1986), although this appears no longer so. Craig and Halderson (1986) noted that pink salmon and, to a lesser degree, chum salmon, occur with any regularity in arctic waters north of Point Hope and presumably maintain small populations in several of the northern drainages; most occurring in streams along the Chukchi Sea coast west of Barrow.

III.B.2.c.(1) Chinook, Sockeye, and Coho Salmon. The northernmost known spawning population of chinook salmon is believed to be in Kotzebue Sound (Healey 1991), however, there are indications of a small run of chinook salmon in the Kugrua River southwest of Point Barrow at Peard Bay (Fechhelm and Griffiths, 2001, citing George, pers. commun.). Small numbers of chinook salmon reportedly are taken each year in the Barrow domestic fishery, which operates in Elson Lagoon (Fechhelm and Griffiths, 2001, citing George, pers. commun.). Strays have been captured in the Kuk River, near Wainwright (Craig and Halderson, 1986).

The northernmost known population of spawning coho salmon is in the Kuchiak River (ADFG anadromous catalog) and coho salmon have occasionally been captured in marine waters farther east, near Prudhoe Bay (Craig and Halderson, 1986). This is particularly important because juvenile fish must over-winter at least

one winter in freshwater before entering the marine environment. Overwintering stream habitat may be reduced by as much as 97-98% by late winter (Craig, 1989).

There are no known stocks of sockeye salmon in arctic waters north of Point Hope (Craig and Halderson, 1986). Sockeye salmon have their northernmost known spawning population in Kotzebue Sound (Stephenson, 2006, citing Burgner, 1991).

Climate change in arctic Alaska (i.e., warming) may facilitate the range expansion of chinook, sockeye, and coho salmon (e.g., Babaluk et al., 2000).

III.B.2.c(2) Pink Salmon. Pink salmon are widely distributed over the northern Pacific Ocean and Bering Sea; they also occur to a lesser degree in arctic waters (Augerot, 2005). Pink salmon are the most abundant salmon species in the Chukchi Sea, although their abundance is greatly reduced compared to waters farther south (Craig and Halderson, 1986; Fechhelm and Griffiths, 2001). Augerot (2005) depicts pink salmon of limited spawning distribution in the Alaskan Arctic.

Craig and Halderson (1986) proposed that pink salmon spawn successfully and maintain small but viable populations in some arctic drainages. Small runs of pink salmon occur in nine drainages north of Point Hope (Craig and Halderson, 1986; Fechhelm and Griffiths, 2001), including the Kuk, Kokolik, Kugrua, and Kukpowruk rivers (Fechhelm et al., 1983 as cited in Kinney, 1985). They are reported as present in the Pitmegea and Utukok rivers.

Unlike other nonsalmonid anadromous fish species in arctic Alaska, the pink salmon is a short-lived species that places all its reproductive effort into a single spawning event, and then dies. With its rigid 2-year lifecycle, there is virtually no reproductive overlap between generations; therefore, every spawning event must be successful for the continued survival of the stock (Craig and Halderson, 1986).

Run timings are inexact. Along the northeastern Chukchi Sea coast, run times in spawning streams may occur in mid-July (Craig and Halderson, 1986). Occurrence of adult salmon in spawning streams in mid- to late July indicates their presence in marine waters along the arctic coast as much as several weeks in advance of the runs.

Schmidt, McMillan, and Gallaway (1983) describe the life cycle of pink salmon:

Eggs are laid in redds dug in gravel. The eggs hatch during the winter however the alevins remain in the gravel, until the yolk sac is absorbed, emerging later in spring. After emerging from the gravel, the fry begin moving downstream. They remain in the estuary for up to a month prior to moving offshore. Little is known of the movements undertaken during the 18 months the salmon spend at sea. It is likely the North Slope populations move westerly towards the Chukchi Sea and upon maturing at the age of 2 years, the salmon then return to their natal streams to spawn in the fall.

Generally, early marine schools of pink salmon fry, often in large, dense aggregations, tend to follow shorelines and, during the first weeks at sea, spend much of their time in shallow water only a few centimeters deep (NMFS, 2005:Appendix F). It has been suggested that this nearshore period involves a distinct ecological life-history stage in both pink and chum salmon. In many areas throughout their ranges, pink salmon and chum salmon fry of similar age and size co-mingle in both large and small schools during early life in the marine environment.

Diet studies show that pink salmon are both opportunistic and generalized feeders and on occasion they specialize in specific prey items (NMFS, 2005:Appendix F). Young-of-the-year probably do not feed significantly during the short period spent in natal streams but feed on copepods and other zooplankton in the estuary (Schmidt, McMillan, and Gallaway, 1983). As the fish grow, larger prey species become important, including amphipods, euphausiids, and fishes (Schmidt, McMillan, and Gallaway, 1983, citing Morrow, 1980 and Scott and Crossman, 1973). Craig and Halderson (1986) state that most (adult) pink salmon caught in Simpson Lagoon had not fed recently (88% empty stomachs, n=17). The only available information on marine feeding is from Kasegaluk Lagoon, where stomachs of 17 captured adult salmon contained mostly fish (chiefly arctic cod), with some amphipods and mysids (Craig and Halderson, 1986,

citing Craig and Schmidt, 1985). Studies indicate that juvenile pink salmon are primarily diurnal feeders (NMFS, 2005:Appendix F).

III.B.2.c(3) Chum Salmon. Chum salmon are widely distributed in arctic waters but are relatively less common than pink salmon (Craig and Halderson, 1986; Babaluk et al., 2000; Fechhelm and Griffiths, 2001). The Pitmegea, Kukpowruk, Kuk, Kukolik, Kuchiak, and Kugrua rivers along the northeastern Chukchi Sea coast are reported to support small populations of chum salmon. They are reported as present in the Utukok and Kuchiak rivers. Individual salmon and small schools have been collected in the Kukpuk River, Kasegaluk Lagoon, and along the Wainwright Coast (Craig and Halderson, 1986; Fechhelm and Griffiths, 2001).

Generally, chum salmon return to spawn as 2-7-year olds (NMFS, 2005). In general chum salmon get older from south to north. Seven-year-old chum are rare and occur mostly in the northern areas (e.g., the Arctic). Slow to rapid growth in the ocean can modify the age at maturity. Slower growth during the second year at sea causes some chum salmon to mature 1 or 2 years later.

Chum salmon fry, like pink salmon, do not overwinter in streams but migrate (mostly at night) out of streams directly to sea shortly after emergence. The timing of outmigration in the arctic is unknown, but occurs between February and June (chiefly during April and May) in more southern waters.

Chum salmon have two habitat requirements that are essential in their life history that make them very vulnerable: (1) reliance on upwelling ground water for spawning and incubation and (2) reliance on estuaries/tidal wetlands for juvenile rearing after migrating out of spawning streams. Chum salmon tend to linger near their natal stream and forage in estuaries and intertidal areas at the head of bays during summer. Estuaries are very important for rearing chum salmon. Rearing juvenile chum salmon use a wide variety of prey species, including invertebrates (including insects) and gelatinous organisms (NMFS, 2005).

In late summer, juvenile chum salmon migrate southward toward the Bering Sea, thereby avoiding the cold waters of the arctic marine environment in winter. Chum salmon eat a variety of foods during their ocean life, e.g., amphipods, euphausiids, pteropods, copepods, fish, and squid larvae.

III.B.2.d. Distribution and Abundance Trends of Fish in the Northeastern Chukchi Sea.

Fish resources of the northeastern Chukchi Sea were last surveyed 15-17 years ago. Additionally, other surveys over the years and area reflect a pattern of temporally and spatially irregular and disjunct sampling. Such disorganized sampling and data reporting greatly influences the information quality necessary to determine population trends and adjustments to environmental perturbations. Establishing a current, accurate, and precise baseline is critical to assessing potential changes to biotic resources. It is unknown if the distribution and abundance information gathered by the last surveys remains an accurate and precise description of arctic fish populations today. This is an important because the Chukchi and Bering seas are considered to be large marine ecosystems serving as principle bellwethers to climate change in North America and the Arctic Ocean.

The climate of the Arctic is changing. Arctic warming is altering the distribution and abundance of marine life in the Arctic. The better known fish resources (i.e., abundant species) can exhibit very large interannual fluctuations in distribution, abundance, and biomass (e.g., capelin, arctic cod, Pacific sand lance, Bering flounder). Climate change experienced in the past and apparently accelerating in arctic Alaska likely is altering the distribution and abundance of their respective populations from what was known from past surveys.

While climatic warming is not distributed evenly across the Arctic, the Bering, Chukchi, and Beaufort seas are clearly experiencing a warming trend (ACIA, 2005). Over the last 50 years, annual average temperatures have risen by about 2-3 °C in Alaska and the Canadian Yukon, and by about 0.5 °C over the Bering Sea and most of Chukotka (ACIA, 2004). The largest changes have been during winter, when near-surface air temperatures increased by about 3-5 °C over Alaska, the Canadian Yukon, and the Bering Sea.

Climate change can affect fish production (e.g., individuals and/or populations) through a variety of means (Loeng, 2005). Direct effects of temperature on the metabolism, growth, and distribution of fishes occur.

Food-web effects also occur through changes in lower trophic-level production or in the abundance of predators, but such effects are difficult to predict. Fish-recruitment patterns are strongly influenced by oceanographic processes such as local wind patterns and mixing and by prey availability during early lifestages. Recruitment success sometimes is affected by changes in the time of spawning, fecundity rates, survival rate of larvae, and food availability.

For example, a climate shift occurred in the Bering Sea in 1977, abruptly changing from a cool to a warm period (ACIA, 2004, 2005). The warming brought about ecosystem shifts that favored herring stocks and enhanced productivity for Pacific cod, skates, flatfish, and noncrustacean invertebrates. The species composition of seafloor organisms changed from being crab dominated to a more diverse assemblage of echinoderms, sponges, and other sea life. Historically high commercial catches of Pacific salmon occurred. The walleye pollock catch, which was at low levels in the 1960's and 1970's (2-6 million metric tons), has increased to levels greater than 10 million metric tons for most years since 1980. Additional recent climate-related impacts observed in the Bering Sea large marine ecosystem include significant reductions in seabird and marine mammal populations, unusual algal blooms, abnormally high water temperatures, and low harvests of salmon on their return to spawning areas. While the Bering Sea fishery has become one of the world's largest, numbers of salmon have been far below expected levels, fish have been smaller than average, and their traditional migratory patterns appear to have been altered.

The Arctic Climate Impact Assessment (ACIA, 2004, 2005) concluded that:

- The southern limit of distribution for colder water species (e.g., Arctic cod) are anticipated to move northward. The distribution of more southerly species (e.g., from the Bering Sea) are anticipated to move northward. Timing and location of spawning and feeding migrations are anticipated to alter;
- Wind-driven advection patterns of larvae may be critical as well as a match/mismatch in the timing of zooplankton production and fish-larval production, thereby influencing productivity (e.g., population abundance and demography);
- Species composition and diversity will change: Pacific cod, herring, walleye pollock, and some flatfish are likely to move northward and become more abundant, while capelin, Arctic cod, and Greenland halibut will have a restricted range and decline in abundance.

The following patterns, can exhibit very large interannual fluctuations in distribution, abundance, and biomass are indicative of changing processes influencing fish-resource distribution, abundance, habitat areas, and demography in response to climatic warming in the Arctic:

- the Bering Sea ecosystem has undergone some significant ecosystem shifts as a result of climatic warming;
- that warming in Alaska and adjacent lands and waters apparently has increased in the last decade and continues to increase;
- that patterns of sea-ice cover in the region are changing (e.g., ACIA, 2004, 2005), thereby influencing aquatic habitats;
- that the conclusions noted by the ACIA (see above) likely have been in action for one or more decades;
- the recent evidence of changing species distributions (i.e., new northern range limits of several fish species better known from the Bering Sea) in the Chukchi Sea as presented by RUSALCA ichthyologists; and
- fish resources are better known (i.e., abundant species).

Adjustments by one or more fish populations often require adjustments within or among large marine ecosystems, influencing the distribution and/or abundance of competitors, prey, and predators. Consequently, it appears reasonable to believe that the composition, distribution, and abundance of fish resources in the northwestern Chukchi Sea is changing and is now different from that measured in the surveys conducted 15-17 years ago or earlier. The magnitude of these differences is unknown.

Trends in Salmon Distribution and Abundance. The occurrence of pink and chum salmon in arctic waters probably is due to their relative tolerance of cold water temperatures and their predominantly marine

life cycle (Craig and Halderson, 1986, citing Salenius, 1973). The expansion of chinook, sockeye, and coho salmon into the Arctic appears restricted by cold water temperatures, particularly in freshwater environments (Craig and Halderson, 1986). Babaluk et al. (2000) noted that significant temperature increases in arctic areas as a result of climate change may result in greater numbers of Pacific salmon in arctic regions. The recent range extensions of pink, sockeye, and chum salmon in the Canadian Arctic, as described by Babaluk et al. (2000), indicate that some Pacific salmon may be expanding their distribution and abundance in the northeastern Chukchi Sea.

III.B.2.e. Invertebrate Fishery Resources.

The Magnuson-Stevens Act defines several additional forms of marine animal and plants that are important fishery resources, including squid and snow crab in the northeastern Chukchi Sea.

Squid occur in the northeastern Chukchi Sea. Squid on occasion (e.g., in 1998 and 2005) strand on the beach near Barrow (George, 2005, pers. commun.). In general, squid can be among the more dominant prey species for some marine fishes, seabirds, and marine mammals. No information was found as to the species inhabiting the areas; hence, we cannot describe their biology and ecology as relating to a baseline description. Essential Fish Habitat has not been determined for squid in the proposed sale area.

The snow crab (*Chionoecetes opilio*) is a dominant benthic species in the northeastern Chukchi Sea (Paul, Paul, and Barber, 1997, citing Slizkin 1989). Essential Fish Habitat has not been determined for snow crab in the proposed sale area.

III.B.3. Essential Fish Habitat.

The U.S. Congress concluded in the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (P.L. 94-265) that the fish off the coasts of the U.S., the highly migratory species of the high seas, the species that dwell on or in the continental shelf of the U.S., and the anadromous species that spawn in U.S. rivers or estuaries, constitute valuable and renewable natural resources. These fishery resources contribute to the food supply, economy, and health of the Nation and provide recreational opportunities. Hence, fish are a valued natural resource in the U.S. The MSA defines "fish" to mean finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds. The term "fishery resource" means any fishery, any stock of fish, any species of fish, and fish habitat.

Recognizing the importance of fish habitat to the productivity and sustainability of U.S. marine fisheries, in 1996 Congress added new habitat conservation provisions to the MSA. Congress asserted the following in the Findings section of the MSA:

One of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats. Habitat considerations should receive increased attention for the conservation and management of fishery resources of the United States (16 U.S.C. 1801 (A)(9)).

The MSA mandated the identification of Essential Fish Habitat (EFH) for managed species as well as measures to conserve and enhance the habitat necessary to fish to carry out their lifecycles. The MSA requires cooperation among the NMFS, the Fishery Management Councils, fishing participants, Federal and State agencies, and others in achieving EFH protection, conservation, and enhancement (see <http://www.nmfs.noaa.gov/habitat/habitatprotection/efh/index.htm>).

Congress defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). The EFH guidelines under 50 CFR 600.10 further interpret the EFH definition as follows:

Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

In Alaska, the NMFS and the North Pacific Fisheries Management Council recently completed the Final EIS for Essential Fish Habitat Identification and Conservation in Alaska (NMFS, 2005). Because commercial fisheries in the Alaskan Chukchi Sea are small relative to other areas commercially fished in Alaska, there are few managed species covered by fishery management plans in the Alaskan arctic. Presently, the five species of Pacific salmon occurring in Alaska are the only managed species with EFH designated in the Alaskan Chukchi Sea.

Essential Fish Habitat for each Pacific salmon species is described and mapped by NMFS (2005). Salmon EFH includes all those freshwater streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon. Marine EFH for the salmon fisheries in Alaska includes all estuarine and marine areas used by Pacific salmon of Alaska origin, extending from the influence of tidewater and tidally submerged habitats to the limits of the U.S. Exclusive Economic Zone (EEZ). This habitat includes waters of the continental shelf (to the 200-m isobath). In the deeper waters of the continental slope and ocean basin, salmon occupy the upper water column, generally from the surface to a depth of about 50 m. Chinook and chum salmon use deeper layers, generally to about 300 m, but on occasion to 500 m. A more detailed description of marine EFH for salmon found in Arctic Alaska is provided below:

- Chinook Salmon
 - Estuarine EFH for juvenile chinook salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Chinook salmon smolts and post-smolt juveniles may be present in these estuarine habitats from April through September (NMFS, 2005).
 - Marine EFH for juvenile chinook salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nmi limit of the EEZ, including the Chukchi Sea. Juvenile marine chinook salmon are at this life stage from April until annulus formation in January or February during their first winter at sea (NMFS, 2005).
 - EFH for immature and maturing adult chinook salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska and ranging from the mean higher tide line to the 200-nmi limit of the U.S. EEZ, including the Chukchi Sea (NMFS, 2005).
- Sockeye Salmon
 - Estuarine EFH for juvenile sockeye salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Under-yearling, yearling, and older smolts occupy estuaries from March through early August (NMFS, 2005).
 - Marine EFH for juvenile sockeye salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska to depths of 50 m and range from the mean higher tide line to the 200-nmi limit of the U.S. EEZ, including the Chukchi Sea from midsummer until December of their first year at sea (NMFS, 2005).
 - EFH for immature and maturing adult sockeye salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m and range from the mean higher tide line to the 200-nmi limit of the U.S. EEZ, including the Chukchi Sea (NMFS, 2005).
- Coho Salmon
 - Estuarine EFH for juvenile coho salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Juvenile coho salmon require year-round rearing habitat and also migration habitat from April to November to provide access to and from the estuary.
 - Marine EFH for juvenile coho salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nmi limit of the U.S. EEZ, including the Chukchi Sea (NMFS, 2005).
 - EFH for immature and maturing adult coho salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to 200 m in depth and

range from the mean higher tide line to the 200-nmi limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean (NMFS, 2005).

- Pink Salmon
 - Estuarine EFH for juvenile pink salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters and generally present from late April through June (NMFS 2005).
 - Marine EFH for juvenile pink salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nmi limit of the U.S. EEZ, including the Chukchi Sea (NMFS 2005).
 - EFH for immature and maturing adult pink salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m and range from the mean higher tide line to the 200-nmi limit of the U.S. EEZ, including the Chukchi Sea. Mature adult pink salmon frequently spawn in intertidal areas and are known to associate with smaller coastal streams.
- Chum Salmon
 - Estuarine EFH for juvenile chum salmon is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters from late April through June (NMFS, 2005).
 - Marine EFH for juvenile chum salmon is the general distribution area for this life stage, located in all marine waters off the coast of Alaska to approximately 50 m in depth from the mean higher tide line to the 200-nmi limit of the EEZ, including the Chukchi Sea (NMFS, 2005).
 - EFH for immature and maturing adult chum salmon is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m and ranging from the mean higher tide line to the 200-nmi limit of the EEZ, including the Chukchi Sea (NMFS, 2005).

III.B.4. Threatened and Endangered Species.

III.B.4.a. Threatened and Endangered Marine Mammals.

All the information in this section about the existing environment of threatened and endangered (T&E) marine mammal species in the Chukchi Sea Proposed Action area is gleaned from MMS's Arctic Region Biological Evaluation (dated March 3, 2006, and available at http://www.mms.gov/alaska/ref/Biological_opinionsevaluations.htm), which addressed the overall effects of oil and gas exploration, development, and production in the Arctic Ocean, and was submitted to the National Marine Fisheries Service, per Section 7 requirements of the Endangered Species Act (ESA).

Background. Section 3(15) of the ESA, as amended, states: "(T)he term 'species' includes any subspecies of fish or wildlife or plants, and any distinct population segment of any vertebrate fish or wildlife which interbreeds when mature" (16 U.S.C. § 1532). Thus, under the ESA, distinct population segments and subspecies are included along with biological species in the definition of "species," and such entities can be listed separately from other subspecies and/or distinct population segments of the same biological species.

Based on the best available information, and on the guidance provided by the NMFS in their letter of September 30, 2005, there are three species of cetaceans that are listed as endangered under the ESA that can occur within or near the Chukchi Sea Planning Area or that could potentially be affected secondarily by activities within the Chukchi Sea Planning Area. The common and scientific names of these species are:

Bowhead whales (*Balaena mysticetus*)
 Fin whales (*Balaenoptera physalus*)
 Humpback whales (*Megaptera novaeangliae*)

The following pages refer to and discuss specific “population stocks” of threatened and endangered marine mammal species. The Marine Mammal Protection Act (MMPA) mandates management of marine mammal population stocks. Under section 3 of the MMPA, the “...term ‘population stock’ or ‘stock’ means a group of marine mammals of the same species, or smaller taxa in a common spatial arrangement, that interbreed when mature” (16 U.S.C. § 1362 (11)). “Population stock” (usually referred to simply as “stock”) designations of many groups of marine mammals have changed over the past 2 decades, in large part due to focused efforts to define the stocks coupled with the availability of relatively new tools with which to examine patterns of genetic variability from the field of molecular genetics. Thus, because of new information, many species of marine mammals that were formerly treated as if comprised of only a single stock, now may be subdivided into multiple stocks, or there may be discussion of whether multiple stocks exist. In the cases of marine mammals for which separate stocks have been delineated, the description and evaluation of potential effects focus on those stocks that may occur within or near the Chukchi Sea Planning Area.

The bowhead whale is the T&E species most likely to be in the Chukchi Sea Planning Area. Fin and humpback whales have limited distribution in the Chukchi Sea.

Summary of Pertinent Information about Listed Marine Mammal Species.

Bowhead Whales. There is one ESA-listed species under the jurisdiction of the NMFS, the bowhead whale, which regularly occurs seasonally within multiple areas of the Chukchi Sea Planning Area and which occurs in areas that could be impacted from oil and gas activities. This population stock of bowheads is the most robust and viable of surviving bowhead populations and, thus, its viability is critical to the long-term future of the biological species as a whole. There is scientific uncertainty about the population structure of bowheads that use the Arctic Ocean. Data indicate that what is currently referred to as the Western Arctic stock (by NMFS) or as the Bering-Chukchi-Beaufort (BCB) Seas stock (by the International Whaling Commission [IWC]) of bowheads is increasing in abundance and has increased in abundance substantially since the last ESA consultation between MMS and NMFS involving the Chukchi Sea Planning Area. There are scientific analyses indicating that BCB Seas bowheads may have reached or are approaching, the lower limit of their historic population size. There are related analyses supporting their removal from the list of T&E species. The cause of the historic decline of this species was over-harvesting by commercial whalers. The primary known current human-related cause of mortality is a regulated subsistence hunt by Alaskan Natives. Conservation concerns include: (1) the introduction of noise and related disturbance from existing, but especially potential future, oil and gas activities, shipping, other vessel traffic, and hunting-related noise in calving, migration, and feeding areas; (2) contamination of their habitat by pollutants from planned and potential future oil and gas activity and by other local and distant pollution sources; (3) uncertain potential impacts of climate warming; vessel strikes; and (4) entanglement. No data are available indicating that, other than historic commercial whaling, any previous human activity has had a significant adverse impact on the current status of BCB Seas bowheads or their recovery. The uncertainty of the stock structure adds some uncertainty to summaries of the status of bowheads that may be impacted by the Proposed Action. Currently available information indicates that bowheads that use the Chukchi Sea Planning Area are resilient at least to the level of human-caused mortality and disturbance that currently exists, and has existed since the cessation of commercial whaling, within their range. Data indicate that at least some bowheads are extremely long lived (100+ years or more), and this longevity can affect the potential for a given individual to be exposed to a high number of disturbance and pollution events in its lifetime. Within or near areas where the Proposed Action could occur, geographic areas of particular importance to this stock include the areas of the spring lead system in both the Chukchi Sea and Beaufort seas and areas that are used for feeding by large numbers of individuals in some years, but not in all years. Available information indicates that most or much of the total calving of the bowheads, which comprise most of the bowhead whales in the world, occurs during the spring migration in, and adjacent to, especially the eastern Chukchi Sea and also the Beaufort Sea spring lead systems. Features of the bowhead’s biology that particularly influence potential effects are its extreme longevity and its dependence on the lead system as its migratory pathway between wintering and summering grounds. Recent data to evaluate bowhead use of the Chukchi Sea Planning Area, or adjacent areas to the south, are lacking.

The following information is from the 2006 Arctic Region Biological Opinion prepared by the NMFS:

There are adverse impacts of the hunting to bowhead whales in addition to the death of animals that are successfully hunted and the serious injury of animals that are struck but not immediately killed. Available evidence indicates that subsistence hunting causes disturbance to the other whales, changes in their behavior, and sometimes temporary effects on habitat use, including migration paths. Modern subsistence hunting represents a source of noise and disturbance to the whales. Whales in the vicinity of a struck whale could be disturbed by the sound of the explosive used in the hunt, the boat motors, and any sounds made by the injured whale. NMFS (2003a) pointed out that whales that are not struck or killed may be disturbed by noise associated with the approaching hunters, their vessels, and the sound of bombs detonating: "...the sound of one or more bombs detonations during a strike is audible for some distance. Acousticians, listening to bowhead whale calls as part of the census, report that calling rates drop after such a strike ..." (NMFS, 2003a:35). We are not aware of data indicating how far hunting-related sounds (for example, the sounds of vessels and/or bombs) can propagate in areas where hunting typically occurs, but this is likely to vary with environmental conditions. It is not known if whales issue an "alarm call" or a "distress call" after they, or another whale, are struck.

NMFS (2003a) reported that:

...whales may act skittish" and wary after a bomb detonates, or may be displaced further offshore (E. Brower, pers. com.). However, disturbances to migration as a result of a strike are temporary (J. George, 1996), as evidenced when several whales may be landed at Barrow in a single day. There is some potential that migrating whales, particularly calves, could be forced into thicker offshore ice as they avoid these noise sources. The experience of Native hunters suggests that the whales would be more likely to temporarily halt their migrations, turn 180 degrees away...(i.e., move back through the lead systems), or become highly sensitized as they continue moving (E. Brower, pers. com.).

Because evidence indicates that bowhead whales are long-lived, some bowhead whales may have been in the vicinity where hunting was occurring on multiple, perhaps dozens or more, occasions. Thus, some whales may have cumulative exposure to hunting activities. This form of noise and disturbance adds to noise and disturbance from other sources, such as shipping and oil and gas-related activities. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (e.g., hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale habitat use. However, we are not aware of information indicating long-term habitat avoidance has occurred with present levels of activity. Additionally, if whales become more "skittish" and more highly sensitized following a hunt, it may be that their subsequent reactions, over the short-term, to other forms of noise and disturbance are heightened by such activity. Data are not available that permit evaluation of this possible, speculative interaction.

The MMS analysis does not support the conclusion that effects from seismic sound, vessel traffic, development and production, and oil spills could lead to mortality of bowheads, the slowing of population recovery, or a population decline. The 2006 Arctic Region Biological Opinion from the NMFS resulted in a nonjeopardy finding for OCS activities in the Chukchi and Beaufort seas, including activities that may result from proposed Chukchi Sea Sale 193.

Fin Whales. Fin whales may occur seasonally in the southwestern Chukchi Sea, north of the Bering Strait along the coast of Chukotka. Their known current summer feeding habitat includes the southern portion, especially the southwestern portion, of the Chukchi Sea along the Asian coast. This species' current use of parts of its range probably is modified due to serious population reduction during commercial hunting. However, there is no indication that fin whales typically occur within the Chukchi Sea project area or in areas directly adjacent to that area, or that they will tend to occur there even if full population recovery occurs. There have been only rare observations of fin whales into the eastern half of the Chukchi Sea. Data indicate they do not typically occur in the northeast Chukchi Sea. The NMFS has concluded that there is no reliable information about population-abundance trends, and that reliable estimates of current or historical abundance are not available, for the entire Northeast Pacific fin whale stock. Fin whales are a widely distributed species. Ranges of population estimates from the 1970's for the entire North Pacific are

14,620-18,630 (Ohsumi and Wada, 1974). There are no recent data to confirm their use or lack of use of the Chukchi Sea Planning Area, or adjacent areas to the south.

Humpback Whales. The northern Bering Sea, Bering Strait, and southern Chukchi Sea along the Chukchi Peninsula are the northern extreme of the range of the humpback whale. Their known current summer feeding habitat includes the southern portion, especially the southwestern portion, of the Chukchi Sea. Historically, large numbers of humpbacks were seen feeding near Cape Dezhnev. Humpback whale use of portions of their range also has been influenced by their severe population reduction due to historic commercial hunting. Available information does not indicate humpback whales inhabit the Chukchi Sea OCS project area. There are no recent data to confirm their lack of use of the Chukchi Sea OCS Planning Area, or adjacent areas to the south.

III.B.4.a(1) Bowhead Whale. The following baseline information about bowhead whales was derived primarily from many MMS reports, scientific literature, and reports and findings from other Federal Agencies. The NMFS, the Federal Agency responsible for managing the bowhead whale, has released a number of pertinent reports and documents. The NMFS issued their *Biological Opinion on Issuance of Annual Quotas Authorizing the Harvest of Bowhead Whales to the Alaska Eskimo Whaling Commission for the Period 2003 through 2007* (NMFS, 2003a). Relatedly, in February 2003 the NMFS published the *Final Environmental Assessment for Issuing Subsistence Quotas to the Alaska Eskimo Whaling Commission for a Subsistence Hunt on Bowhead Whales for the Years 2003 through 2007* (NMFS, 2003b). In June 2006, the NMFS released their *Biological Opinion on Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska, and Authorization of Small Takes Under the Marine Mammal Protection Act*. The USDOC NOAA and the North Slope Borough (NSB) convened the first Workshop on Bowhead Whale Stock Structure Studies in the Bering-Chukchi-Beaufort Seas: 2005-2006 (USDOC, NOAA and NSB, 2005). The second meeting of this group is scheduled for spring 2006. The Scientific Committee of the IWC reviewed and critically evaluated new information available on the bowhead whale at their 2003 and 2005 meetings (IWC, 2003a; IWC, 2005a,b) and conducted an in-depth status assessment of this population in 2004 (IWC, 2004a,b). The MMS published *Aerial Surveys of Endangered Whales in the Beaufort Sea, Fall 2002-2004* (Monnett and Treacy, 2005). The *Final 2003 Alaska Marine Mammal Stock Assessment* (Angliss and Lodge, 2003) for this stock remains the most recent finalized stock assessment available, as no stock assessment was finalized in 2004. There is a revised draft stock assessment for 2005 available for this population (Angliss and Outlaw, 2005). The NMFS published the *Notice of Determination - Endangered and Threatened Species; Final Determination on a Petition to Designate Critical Habitat for the Bering Sea Stock of Bowhead Whales* (67 FR 55767).

III.B.4.a(1)(a) ESA Status of the Western Arctic Stock. The bowhead whale was listed as endangered on June 2, 1970. No critical habitat has been designated for the species. The NMFS 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 NMFS 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.

All available information (e.g., Shelden et al., 2001; IWC, 2004a,b; IWC, 2005a,b; NMFS, 2003a,b); indicates that the BCB Seas population of bowheads is increasing, resilient to the level of mortality and other adverse effects that are currently occurring due to the subsistence hunt or other causes, and may have reached the lower limit of the estimate of the population size that existed prior to intensive commercial whaling.

III.B.4.a(1)(b) Population Structure and Current Stock Definitions. The IWC currently recognizes five stocks of bowheads for management purposes (IWC, 1992), with one of them being the BCB Seas stock. The BCB Seas bowheads are the most robust, viable, and (Angliss and Outlaw, 2005:209). The Scientific Committee of the IWC previously had concluded that the BCB Seas bowheads comprise a single stock (DeMaster et al., 2000, as cited in IWC, 2003a). However, after an in-depth evaluation of available data, the Scientific Committee (IWC, 2004a) concluded that there is temporal and spatial heterogeneity among these bowheads, but analyses do not necessarily imply the existence of subpopulations with limited

interbreeding; it was premature to draw conclusions about the relative plausibility of any hypotheses about stock structure or to reject any of them. Subsequently, “The Bowhead Group” (USDOC, NOAA and NSB, 2005) created a set of five stock-structure hypotheses, modified this set, and currently recommends testing of the following hypotheses: (1) one stock of BCB Seas bowheads as described and previously accepted by the IWC (Rugh et al., 2003); (2) one stock with generational gene shift; (3) temporal migration—there are two stocks and two putative wintering area, with the two stocks migrating separately in the spring but together in the fall; (4) segregation of stocks; spatial segregation of stocks; and (5) Chukchi Circuit—one population migrates from the Bering Sea to the Beaufort Sea in spring and back again in the fall, whereas the second leaves the Bering Sea, heads northwest along the Chukotka coast, heads towards the Barrow Canyon and then back to the Bering Sea (see USDOC, NOAA and NSB, 2005 for detailed descriptions and discussions). After more recent information provided to the IWC Subcommittee on Bowhead, Right and Gray Whales (IWC, 2005b), the subcommittee agree that what is termed the “Oslo Bump” (a significant increase in genetic difference between pairs of whales sampled approximately 1 week apart at Barrow during the fall migration) appears to be a real pattern within the data that are available. Additional data are needed to determine if these data actually typify the bowhead population, and there is no single hypothesis adequate to explain the pattern. Stock structure is unclear at the time of this writing (see IWC, 2004b; 2005a,b; USDOC, NOAA and NSB, 2005 for detailed descriptions and discussions). The IWC will be conducting an Implementation Review focusing on the stock structure of the BCB Seas bowhead with the goal of completing this at the 2007 annual meeting (IWC, 2005a). Two related intersessional workshops, one that occurred in 2005 and one that occurred in spring 2006, are focusing on this topic (IWC, 2005a,b).

III.B.4.a(1)(c) Past and Current Population Abundance. Woody and Botkin (1993) estimated that the historic population abundance of bowheads in the Western Arctic stock was between 10,400 and 23,000 whales in 1848 before the advent of commercial whaling, which severely depleted bowhead whales. They estimated that between 1,000 and 3,000 animals remained in 1914 near the end of the commercial-whaling period.

Based on both survey data and the incorporation of acoustic data, the abundance of the Western Arctic stock of bowhead whales was estimated between 7,200 and 9,400 individuals in 1993 (Zeh, Raftery, and Schaffner, 1995), with 8,200 as the best population estimate. This estimate was recently revised by Zeh and Punt (2004) to 8,167 (CV= 0.017) and is the estimate used by the NMFS in their draft 2005 stock assessment (Angliss and Outlaw, 2005). An alternative method produced an estimate of 7,800 individuals, with a 95% confidence interval of 6,800-8,900 individuals. Data indicate that the Western Arctic stock increased at an estimated rate of about 3.1% (Raftery, Zeh, and Givens, 1995) to 3.2% (Zeh, Raftery, and Schaffner, 1995) per year from 1978-1993, and likely was due to a combination of improved data and better censusing techniques, along with an actual increase in the population.

George et al. (2004) estimated abundance in 2001 to be 10,470 (SE = 1,351) with a 95% confidence interval of 8,100-13,500. This estimate indicates a substantial increase in population abundance since 1993 and suggests that population abundance may have reached the lower limits of the aforementioned historical population estimate. In 2004, Zeh and Punt (2004, cited in Angliss and Outlaw, 2005) provided the IWC a slightly revised 2001 population estimate of 10,545 CV(N) =0,128. George et al. (2004) estimated that the annual rate of increase (ROI) of the population from 1978-2001 was 3.4% (95% CI 1.7%-5%) and Brandon and Wade (2004) estimate an ROI of 3.5% (95% CI 2.2-4.9%). The number of calves (121) counted in 2001 was the highest ever recorded for this population and this fact, when coupled with the estimated rate of increase, suggests a steady recovery of this population (George et al., 2004). This steady recovery since 1993 is likely due to low anthropogenic mortality, a relatively pristine habitat, and a well-managed subsistence hunt (George et al., 2004).

III.B.4.a(1)(d) Reproduction, Survival and Nonhuman Sources of Mortality. Information gained from the various approaches at aging BCB Seas bowhead whales and estimating survival rates all suggest that bowheads are slow-growing, late-maturing, long-lived animals with survival rates that are currently high (Zeh et al, 1993; Schell and Saupe, 1993; George et al., 1999). Several studies suggest that bowhead whales reach sexual maturity in their late teens to mid-twenties (Koski et al., 1993; Schell and Saupe, 1993; George et al., 1999; Lubetkin et al., 2004, as cited in Rosa et al., 2004).

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; Reese et al.

(2001). Mating probably peaks in March-April (IWC, 2004b). Gestation has been estimated to range between 12 and 16 months (Nerini et al., 1984, as reported in Reese et al., 2001; Reese et al., 2001; Koski et al., 1993; IWC, 2004b). Koski et al. (1993) reported that calving occurs from March to early August, with the peak probably occurring between early April and the end of May. The conception date and length of gestation suggests that calving is likely to occur in mid-May to mid-June, when whales are between the Bering Strait and Point Barrow (in the Chukchi Sea). Reese et al. (2001) said this is consistent with other observations in the region, including: (a) relatively few neonate-cow pairs reported by whalers at St. Lawrence Island; (b) many neonates seen during the whale census in late May; (c) relatively few term females taken at Barrow; (d) taken females with term pregnancies appeared close to parturition; and (e) most of the herd believed to have migrated past Barrow by late May. Females give birth to a single calf probably every 3-4 years.

Discussion during the in depth assessment by the IWC (2004b) also indicated that differences in lipid content between females of the same length and size are attributable to pregnant versus nonpregnant females. This may imply a high biological cost of reproduction, a fact noteworthy in considering the potential impact of excluding females from feeding areas. George et al. (2004, cited in IWC, 2004b) estimated pregnancy rates of 0.333/year and an estimated interbirth interval of 3.0 years using data from postmortem examinations of whales landed at Barrow and Kaktovik in the winter.

There is little information regarding causes of natural mortality for BCB Seas bowhead whales. Bowhead whales have no known predators except, perhaps, killer whales and subsistence whalers. The frequency of attacks by killer whales probably is low (George et al., 1994). A relatively small number of whales likely die as a result of entrapment in ice (Philo, Carroll, and Yokel, 1993). Little is known about the effects of microbial or viral agents on natural mortality.

The discovery of traditional whaling tools recovered from five bowheads landed since 1981 (George et al., 1995) and estimates of age using aspartic-acid racemization techniques (George et al., 1999) both suggest bowheads can live a very long time, in some instances more than 100 years. The oldest harvested females whose ages were estimated using corpora albicans accumulation to estimate female age were >100 years old (George et al., 2004, cited in IWC, 2004b). Discussion in the IWC (2004b) indicated that neither lifespan nor age at sexual maturity is certain. Lifespan may be greater than the largest estimates. Using aerial photographs of naturally marked bowheads collected between 1981 and 1998, Zeh et al. (2002) estimated “the posterior mean for bowhead survival rate...is 0.984, and 95% of the posterior probability lies between 0.948 and 1,” which is consistent with other bowhead life-history data.

III.B.4.a(1)(e) Migration, Distribution, and Habitat Use. Information about the migration, distribution, and habitat use of bowheads provides insight into areas where bowheads might be exposed to OCS activities, when they might be exposed, and what the significance of their exposure in certain geographic areas might be relative to that in other areas. The BCB Seas bowheads generally occur north of 60° N. latitude and south of 75° N. latitude (Angliss and Outlaw, 2005) in the Bering, Chukchi, and Beaufort seas (Fig. III.B-1). They have an affinity for ice and are associated with relatively heavy ice cover and shallow continental shelf waters for much of the year.

III.B.4.a(1)(e)1 Winter and Other Use of the Bering Sea. Bowhead whales of the BCB Seas stock currently overwinter in the central and western Bering Sea (Fig. III.B-3). Most mating probably occurs in the Bering Sea. The amount of feeding in the Bering Sea in the winter is unknown as is the amount of feeding in the Bering Strait in the fall (Richardson and Thomson, 2002). In the Bering Sea, bowheads frequent the marginal ice zone, regardless of where the zone is, and polynyas. Important winter areas in the Bering Sea (before migrating begins) include polynyas along the northern Gulf of Anadyr, along leads and polynyas adjacent to the Asian coastline, south of St. Matthew Island, and near St. Lawrence Island (Moore and Reeves, 1993; Mel'nikov, Zelensky, and Ainana, 1997). Mel'nikov, Zelensky, and Ainana (1997) summarized that in years when there is little winter ice, bowheads inhabit the Bering Strait and potentially inhabit southern portions of the Chukchi Sea.

During their southward migration in the autumn, bowheads pass through the Bering Strait in late October through early November on their way to overwintering areas in the Bering Sea. Large numbers of bowheads were taken in June and July during commercial whaling over large portions of the northwestern and northcentral Bering Sea (Dahlheim et al., 1980:Fig. 1b, from Townsend, 1935).

III.B.4.a(1)(e)2 Spring Migration. Some, or nearly all, of the bowheads that winter in the Bering Sea migrate northward up both the eastern and western sides of the Bering Strait, through the Bering Strait to the Chukchi Sea, and through the Alaskan Beaufort Sea to summer feeding grounds in the Canadian Beaufort Sea (Mel'nikov, Zelensky, and Ainana, 1997; Mel'nikov et al., 2004) (Fig. III.B-3). The bowhead northward spring migration probably begins most years in April (possibly late March depending on ice conditions) and early May, and appears to coincide with ice breakup. The whales 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. It is thought to occur after the peak of breeding, which is believed to occur in March-April (C. George, cited in IWC, 2004b). During spring aerial surveys in the late 1980's, bowheads were documented to be migrating in shorefast leads and polynyas up the coast of northwestern Alaska (Mel'nikov, Zelensky, and Ainana, 1997:Figs. 4 and 5).

Based on shore-based surveys in 1999-2001, Mel'nikov et al. (2004) observed that the start of spring migration from the Gulf of Anadyr varies between cold and mild years by up to 30 days, but in both instances, continues at least until June 20. Mel'nikov et al. (2004) also reported that weather influenced migration, with migration seeming to stop when there were storms or high winds in the western Bering Strait or at the exit from the Gulf of Anadyr.

The migration past Barrow takes place in pulses in some years (e.g., in 2004) but not in others (e.g., 2003) (Koski et al., 2004, as cited in IWC, 2004b). At Barrow, the first migratory pulse is typically dominated by juveniles. This pattern gradually reverses and by the end of the migration, there are almost no juveniles. Currently, the whales are first seen at Barrow around April 9-10. In later May (May 15-June), large whales and cow/calf pairs are seen (H. Brower, as cited in USDOC, NOAA and NSB, 2005; IWC, 2004b). Koski et al. (2004) found that cow/calf pairs constituted 31-68% of the total number of whales seen during the last few days of the migration. The rate of spring migration of cow/calf pairs was slower and more circuitous than other bowheads.

Data from several observers indicate that bowheads migrate underneath ice and can break through ice 14-18 cm (5.5-7 in) 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 to mid-June, they move easterly through or near offshore leads and offshore of the barrier islands in the central Alaskan Beaufort Sea.

III.B.4.a(1)(e)3 Summer Migration. Bowhead whales have been observed near Barrow in midsummer (e.g., Brower, as cited in USDOI, MMS, 1995a). Mel'nikov, Zelensky, and Ainana (1998) suggested that "...Barrow Canyon is a focal feeding area for bowheads and that they 'move on' from there only when zooplankton concentrations disperse," which is consistent with the timeframe of earlier observations summarized by Moore (1992). Bowheads arrive on their summer feeding grounds near Banks Island from mid-May through June/July (IWC, 2005b) and remain in the Canadian Beaufort Sea and Amundsen Gulf until late August or early September (Moore and Reeves, 1993) (Fig. III.B-3). Incidental sightings suggest that bowhead whales may occupy the Chukchi Sea in the summer more regularly than commonly believed. Scientists maintain that a few bowheads swim northwest along the Chukotka coast in late spring and summer in the Chukchi Sea, but it is unclear if these are "early-autumn" migrants or whales that have summered nearby or elsewhere (Moore et al., 1995; Moore, 1992; USDOC, NOAA, and NSB, 2005; Mel'nikov, Zelensky, and Ainana, 1998).

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). Evidence indicates that the number of bowheads that inhabit the BCB Seas has increased substantially since the time of the surveys (Brandon and Wade, 2004, cited in IWC, 2004b) in the Chukchi Sea. Temporal and spatial patterns of distribution also may be modified. Conversely, earlier information may have inferred less variability in distribution than actually existed.

The MMS funded large-scale surveys in this area when there was oil and gas leasing and exploration, but while surveys in the Beaufort Sea have continued, the last surveys in the Chukchi Sea were about 15 years ago. These data were summarized by Mel'nikov, Zelensky, and Ainana (1997), Moore (1992), Moore and Clarke (1990), and Moore, DeMaster, and Dayton (2000). We have plotted counts of bowheads in the Chukchi Sea during those surveys (Fig. III.B-4), because they visually provide limited insight into areas

where bowheads may be exposed to oil and gas activities should they occur in the Chukchi Sea Planning Area. However, we caution against over-interpretation of these data out of context of survey effort and, because these data were collected between 1979 and 1991, they should not be interpreted as indicating current use of the Chukchi Sea by bowhead whales; they are the best data available.

III.B.4.a(1)(e)4 Fall Habitat Use and Migration. Those bowheads that have been summer feeding in the Canadian Beaufort Sea begin moving westward into Alaskan waters in August and September. While few bowheads generally are seen in Alaskan waters until the major portion of the migration takes place (typically mid-September to mid-October), in some years bowheads are present in substantial numbers in early September (Greene and McLennan, 2001; Treacy, 1998). In September 1997, Treacy (1998) reported sighting 170 bowheads, including 6 calves, between Cross Island and Kaktovik, a large number of bowheads between Barrow and Cape Halkett; however, in early October a large number of bowhead whales were still present between Dease Inlet and Barrow.

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). Inupiat whalers report that smaller whales precede large adults and cow-calf pairs on the fall migration (Braham et al., 1984, as reported in Moore and Reeves, 1993). During the autumn migration Koski and Miller (2004, cited in IWC, 2004b) found decreasing proportions of small whales and increasing proportions of large whales as one moved offshore. "Mothers and calves tended to avoid water depths <20 m." (Koski and Miller, cited in IWC, 2004b:14). These authors also found that in the Central Beaufort Sea in late August, the vast majority of the whales were subadults and this percentage declined throughout the autumn to about 35% by early October. They reported that mother/calf pairs "arrived in September and were common until early October" (Koski and Miller, 2004, cited in IWC, 2004b).

Individual movements and average speeds (approximately 1.1-5.8 km/hour) vary widely (Wartzog et al., 1990; Mate, Krutzikowsky, and Winsor, 2000). Much faster speeds (e.g., up to 9.8 ± 4.0 km/hour) were estimated for bowheads migrating out of the Gulf of Anadyr during the northward spring migration (Mel'nikov et al., 2004). 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 NMFS, 1999).

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 (147°-150° W. longitude) migrate closer to shore in light and moderate ice years and farther offshore in heavy ice years, with median distances offshore of 30-40 km (19-25 mi) in both light and moderate ice years and 60-70 km (37-43 mi) 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.

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 km (93 mi) 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 Chukotka Peninsula. However, sightings north of 72° N. latitude suggest that at least some whales migrate across the Chukchi Sea farther to the north. Mel'nikov, Zelensky, and Ainana (1997) argued that data suggest that after rounding Point Barrow, some bowheads head for the northwestern coast of the Chukotka Peninsula and others proceed primarily in the direction of the Bering Strait and into the Bering Sea. Mel'nikov (in USDOC, NOAA, and NSB, 2005) reported that abundance increases along northern Chukotka in September as whales come from the north. More whales are seen along the Chukotka coast in October.

J.C. George (cited in IWC, 2004b) noted that bowheads pass through the Bering Strait into the Bering Sea between October and November on their way to overwintering areas in the Bering Sea.

The timing, duration, and location of the fall migration along the Chukotka Peninsula are highly variable and are linked to the timing of freezeup (Mel'nikov, Zelensky, and Ainana, 1997). Whales migrate in "one short pulse over a month" in years with early freezeup, but when ice formation is late, whales migrate over a period of 1.5-2 months in 2 pulses (Mel'nikov, Zelensky, and Ainana, 1997:13).

III.B.4.a(1)(e)5 Known Use of the Chukchi Sea by Bowheads. The Chukchi Sea Planning Area is an integral part of the total range of BCB Seas bowhead whales, and portions of this planning area are either part of or are primary calving ground during the spring for these whales. During the spring (widely bracketed as mid-March to approximately mid-June), bowheads migrate through leads on their way to summer feeding grounds. This lead system is an apparently obligate pathway for this population. Most calving apparently occurs during the spring migration between April and early June. In some years, parts of the spring lead system in the Chukchi Sea west, northwest, and southwest of Barrow are used as feeding areas over extended periods of time during the spring migration, but this use is inconsistent. Bowhead whales have been observed throughout the summer in waters along the northeastern Chukchi Peninsula of Russia (and along the southeastern portion of the Chukchi Peninsula in the Bering Sea). In the autumn, bowheads are in the Chukchi Sea as part of their autumn migration back to the Bering Sea from about mid-September through October, passing through Bering Strait to the Bering Sea between October and November. Some of the bowheads whales are very far north (e.g., 72° N. latitude) in the Chukchi Sea. After passing Barrow, some of the whales head towards Wrangell Island and then follow the Asian coast southeast to the Bering Sea. Observations indicate bowheads feed along the Russian coast in the autumn. Lee et al. (2005) summarized that both bulk body tissue and baleen isotopic values indicate that the Bering and Chukchi seas are the predominant feeding areas for adults and subadults. Some of the feeding in the western Alaskan Beaufort Sea (e.g., west of Harrison Bay) is on prey advected from the Chukchi Sea.

III.B.4.a(1)(e)6 Feeding Behavior. The importance of feeding areas for bowheads is an issue of concern to Inupiat whalers and is a major issue in evaluating the potential significance of any effect that may occur as a result of oil and gas activities Chukchi Sea Area. Both MMS and the NSB believe that there are major questions about bowhead whale feeding that remain to be answered (Stang and George, 2003). Most of the available information about this topic (and presented in this EIS) is based on studies and observations conducted in the Alaska Beaufort Sea.

Available data indicate that bowhead whales feed in both the Chukchi and Beaufort seas and that this use varies in degree among years, among individuals, and among areas. It is likely that bowheads continue to feed opportunistically where food is available as they move through or about the Arctic Ocean, similar to what they are thought to do during the spring migration.

Bowheads are filter feeders, filtering prey from the water through baleen fibers in their mouth. They apparently feed throughout the water column, including bottomfeeding as well as surface skim feeding (Würsig et al., 1989). Skim feeding can occur when animals are alone and conversely may occur in coordinated echelons of over a dozen animals (Würsig et al., 1989). Food items most commonly found in the stomachs of harvested bowheads include euphausiids, copepods, mysids, and amphipods. Euphausiids and copepods are thought to be their primary prey. Lowry, Sheffield, and George (2004) documented that other crustaceans and fish also were eaten but were minor components in samples consisting mostly of copepods or euphausiids.

Observations from the 1980's documented that some feeding occurs in the spring in the northeastern Chukchi Sea, but this feeding was not consistently seen (e.g., Ljungblad et al., 1987; Carroll et al., 1987). Stomach contents from bowheads harvested between St. Lawrence Island and Point Barrow during April into June also indicated it is likely that some whales feed during the spring migration (Carroll et al., 1987; Shelden and Rugh, 1995, 2002). Carroll et al. (1987) reported 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 (1995) concluded that: "In years when oceanographic conditions are favorable, the lead system near Barrow may serve as an important feeding ground in the spring (Carroll et al., 1997)."

It is known that bowhead whales feed in the Canadian Beaufort in the summer and early fall (e.g., Würsig et al., 1985), and in the Alaskan Beaufort in late summer/early fall (Lowry and Frost, 1984; Ljungblad et al., 1986; Schell and Saupe, 1993; Lowry, Sheffield, and George, 2004; summarized in Richardson and Thomson, 2002). Available information indicates it is likely there is considerable inter-annual variability in the locations where feeding occurs during the summer and fall in the Alaska Beaufort Sea, in the length of time individuals spend feeding, and in the number of individuals feeding in various areas in the Beaufort Sea.

In at least some years, 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 (Akootchook, 1995, as reported in NMFS, 2001). The Inupiat believe that whales follow the ocean currents carrying food organisms (e.g., Napageak, 1996, as reported in NMFS, 2001). Bowheads have been observed feeding not more than 1,500 feet (ft) offshore in about 15-20 ft of water (Rexford, 1979, as reported in NMFS, 2001). Nuiqsut Mayor Nukapigak testified at the Nuiqsut Public Hearing on March 19, 2001, that he and others saw a hundred or so bowhead whales and gray whales feeding near Northstar Island (USDOI, MMS, 2002). Some bowheads appear to feed east of Barter Island as they migrate westward (Thomson and Richardson, 1987). Data from MMS's BWASP surveys (e.g., Treacy, 1998, 2000) shows high numbers of whales, many of which were feeding, in some areas over relatively long periods (e.g., weeks) of time in some years (e.g., 1997) in areas in the western Alaskan Beaufort) but not in others.

Based on stomach-content data supplemented by behavioral evidence, many bowheads that pass through the eastern Alaskan Beaufort Sea during late summer and autumn feed there. Based on examination of the stomach contents of whales harvested in the autumn between 1969 and 2000, Lowry, Sheffield, and George (2004) found that copepods were the dominant prey species by volume. 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. Of the 77 whales classified as feeding whales, there were estimates of stomach volume for 16 autumn-feeding whales. Euphausiids were the dominant prey species by volume.

It is unclear how important this feeding is in terms of meeting the annual food needs of the population or to meeting the food needs of particular segments of the population (e.g., see discussion in Richardson and Thomson, 2002). Many assumptions, such as those about residence time, an approximations influence current conclusions. Because marked individuals have not been studied, it is unclear how much variability also exists among classes of individuals or individuals within a class in habitat residency times, or what factors influence residency times.

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 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 (mg/m^3). Most whales observed where zooplankton were sampled were subadults. "Adult bowheads tend to feed where large copepods predominate" (Richardson and Thomson, 2002:xxv).

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. 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. Carbon-isotope analysis of bowhead baleen has indicated that a significant amount of feeding may occur in wintering areas (Schell, Saupe, and Haubenstock, 1987). However, isotope data indicate that primary productivity in the Bering and southern Chukchi seas is declining and 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. They found that 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. However, 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 and 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.

Much of the isotopic evidence seems to indicate that especially adult bowhead whales feed primarily on prey from the Bering and/or Chukchi Sea (Schell, Saupe, and Haubenstein, 1987; Schell and Saupe, 1993; Lee and Schell, 2002). Hoekstra et al. (2002) found seasonal values were consistent for all age classes of bowhead whales and suggested that the Bering and Beaufort seas are both important regions for feeding. In contrast, 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.

Thomson, Koski, and Richardson (2002) tried to reconcile the low estimates of summer feeding, as indicated by 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. They concluded that 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%. 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.

Assumptions about residence times influence these energetics-related estimates. As noted, available data indicate there is variability in habitat use among years. Because marked individuals have not been studied, it is unclear how much variability also exists among individuals in habitat residency times or what factors influence residency times.

The amount of feeding in the Chukchi Sea and Bering Strait in the fall is unknown as is the amount of feeding in the Bering Sea in the winter (Richardson and Thomson, 2002). Richardson and Thomson (2002:xxxviii) concluded that: "...behavioral, aerial-survey, and stomach-content data, as well as certain energetics data...show that bowheads also feed widely across the eastern and central Beaufort Sea in summer and fall." In mid- to late fall, at least some bowheads feed in the southwest Chukchi. Detailed feeding studies have not been conducted in the Bering Sea in the winter.

Thomson, Koski, and Richardson (2002) offered a feeding scenario, parts of which are speculative, that might be consistent with all these data. In this scenario, 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.

Richardson and Thomson (2002) pointed out that the isotopic and behavioral and stomach content data might not be in conflict, if prey availability in the Chukchi and/or Bering Sea were “notably better” than in the eastern Beaufort Sea. They also point out that: “...it is difficult to understand why bowheads would migrate from the Bering-Chukchi area to the Beaufort Sea if feeding in the Beaufort Sea were unimportant.”

Richardson and Thomson (2002) note that while the study has provided many new data about bowhead feeding ecology and related biology, “...there are still numerous approximations, assumptions, data gaps, and variations of opinion regarding the interpretation of data. This is inevitable.... The authors do not claim that the project has resolved all uncertainty about the importance of the eastern Alaskan Beaufort Sea for feeding by bowhead whales....”

Thus, the aforementioned study acknowledges certain limitations and the results of this study confirmed that the eastern Alaskan Beaufort Sea is used by bowhead whales for feeding (Stang and George, 2003). Richardson and Thomson (2002) summarized that this use varies widely in degree among years and individuals.

Summary. All recent available information indicates that the population has continued to increase in abundance over the past decade and may have doubled in size since about 1978. The estimated current annual rate of increase is similar to the estimate for the 1978-1993 time series. Most of the available information about bowhead whale feeding pertains to the Alaskan Beaufort Sea. Bowheads feed in the Alaskan Beaufort Sea, but the extent and location of that feeding varies widely among years and locations. There are locations in the Beaufort Sea and the western Chukchi Sea where large numbers of bowheads have been observed feeding in many years. However, the significance of feeding in particular areas to the overall food requirements of the population or segments of the population is not clear. Bowheads are extremely long lived, slow growing, slow to mature, and currently have high survival rates. These features affect their vulnerability to pollution and disturbance in their environment. They are also unique in their ecology and their obligate use of lead systems to transit to summering grounds and calve during the spring northward migration. Recent data on distribution, abundance, or habitat use in the Chukchi Sea Planning Area are not available. Since MMS and NMFS consulted on oil and gas leasing in the Chukchi Sea Planning Area, significant changes in the arctic environment have occurred and the population of bowheads has apparently greatly increased in abundance.

III.B.4.a(2) Fin Whale. Fin whales are large, fast-swimming baleen whales (Reeves, Silber, and Payne, 1998). Adults range between 20 and 27 m (~65-89 ft) in length (Reeves, Silber, and Payne, 1998; Perry, DeMaster, and Silber, 1999a). They inhabit and feed in the Bering Sea throughout many months of the year and have been observed within the southwestern Chukchi Sea, along the northern coast of Chukotka. This area of the Chukchi was an important part of their historic range. The distribution and relative abundance of fin whales in these areas varies seasonally.

III.B.4.a(2)(a) ESA Status. Fin whales were listed as endangered under the ESA in 1973 (Perry, DeMaster, and Silber, 1999a) and as depleted under the MMPA. Under the 1994 amendments to the MMPA, they are categorized as a strategic stock and listed in Appendix I of CITES (Reeves, Silber, and Payne, 1998). Hunting of fin whales in the North Pacific was regulated under the 1946 International Convention for the Regulation of Whaling. The IWC began managing the commercial take of fin whales in the North Pacific in 1969 (Allen, 1980; Reeves et al., 1999) and prohibited their harvest in the North Pacific in 1976. In July 1998, NMFS released a joint *Draft Recovery Plan for the Fin Whale Balaenoptera*

physalus and Sei Whale Balaenoptera borealis (Reeves, Silber, and Payne, 1998). No critical habitat has been designated or proposed for fin whales in the North Pacific.

III.B.4.a(2)(b) Population Structure and Current Stock Definitions. The NMFS (Angliss and Lodge,

2002; Angliss and Outlaw, 2005:rev. 10/24/04) currently considers stock structure in fin whales to be equivocal. There is a lack of consistency among national and international regulatory entities in the number of stocks recognized. The NMFS (Angliss and Outlaw, 2005:rev.10/24/04) currently recognizes three population stocks of fin whales in U.S. Pacific waters: an Alaska or Northeast Pacific Stock, a California/Washington/Oregon Stock, and a Hawaii Stock. Investigators have reached different conclusions about the number and locations of population stocks in the North Pacific. However, tag recoveries (Rice, 1974) indicate that animals whose winter habitat includes the coast of southern California summer in locations from central California to the Gulf of Alaska; and individuals from the North American Pacific coast have been reported at locations as varied as central Baja California to the Bering Sea in the summer. Based on blood typing, morphology, and marking data, Fujino (1960) identified three "subpopulations" of fin whales in the North Pacific: the East China Sea, the eastern sides of the Aleutians, and the western sides of the Aleutians (Donovan, 1991). After examination of histological and tagging data, Mizroch, Rice, and Breiwick (1984) suggested five possible stocks. In 1971, the IWC divided North Pacific fin whales into two management units for the purposes of establishing catch limits: the East China Sea Stock and the rest of the North Pacific (Donovan, 1991).

III.B.4.a(2)(c) Past and Current Population Abundance. During visual cetacean surveys in July and August 1999 in the central Bering Sea, and in June and July 2000 in the southeastern Bering Sea, fin whale abundance estimates were almost five times higher in the central Bering Sea (provisional estimate of 3,368; CV = 0.29) (where most sightings were in a region of particularly high productivity along the shelf break) than in the southeastern Bering Sea (provisional estimate of 683; CV = 0.32) (Moore et al., 2002). During sighting cruises in July-August 2001-2003 of coastal waters (up to 85 km offshore) between the Kenai Peninsula (150° W. longitude) to Amchitka Pass (178° W. longitude), fin whales were observed from east of Kodiak Island to Samalga pass (Zerbini et al., In prep., as cited in Angliss and Outlaw, 2005:rev. 10/24/04). These authors also estimated that 1,652 (95% CI = 1142-2389) fin whales occurred in this area. Based on these data, and those of Moore et al. (2002), NMFS provided an "initial estimate" of abundance of 5,703 fin whales west of the Kenai Peninsula. The NMFS considers this a minimum estimate of abundance for the stock, because no estimate is available east of the Kenai Peninsula (Angliss and Outlaw, 2005:rev. 10/24/04).

The NMFS has concluded that there is no reliable information about population-abundance trends, and that reliable estimates of current or historical abundance are not available, for the entire Northeast Pacific fin whale stock (Angliss and Lodge, 2002; Angliss and Outlaw, 2005:rev. 10/24/04). They provided a Potential Biological Removal for the Northeast Pacific Stock of 11.4.

Estimates of population abundance in the North Pacific prior to commercial exploitation range from 42-45,000 (Ohsumi and Wada, 1974). Angliss and Outlaw (2005:rev. 10/24/04, p. 197) cite a revised, unpublished February 2003 version of IWC Bureau of International Whaling Statistics data, stating that "Between 1925 and 1975, 47,645 fin whales were reported killed throughout the North Pacific."

III.B.4.a(2)(d) Reproduction, Survival, and Nonhuman-Related Sources of Mortality. Lockyer (1972) reported the age at sexual maturity in fin whales, for both sexes, to range from 5-15 years, while the average length is approximately 17.2 m (see references in Perry, DeMaster, and Silber, 1999a). Mating and calving are believed to occur on wintering grounds (Perry, DeMaster, and Silber, 1999a). A single calf is born after a gestation of about 12 months and weaned between 6 and 11 months of age (Best, 1966; Gambell, 1985). Calving intervals range between 2 and 3 years (Agler et al., 1993). About 35-40% of adult fin whale females give birth in any given year (Mizroch et al., In prep.).

There is little information about natural causes of mortality (Perry, DeMaster, and Silber, 1999a). The NMFS summarized that "There are no known habitat issues that are of particular concern for this stock" (Angliss and Lodge, 2002, 2005). Perry, DeMaster, and Silber (1999a:51) listed the possible influences of disease or predation as "Unknown."

III.B.4.a(2)(e) Migration, Distribution, and Habitat Use. Fin whales are widespread throughout temperate oceans of the world (Leatherwood et al., 1982; Perry, DeMaster, and Silber, 1999a; Reeves, Silber, and Payne, 1998). During the "summer" (defined by Mizroch et al., In prep. as April-October) fin whales inhabit temperate and subarctic waters throughout the North Pacific including the Gulf of Alaska, Bering Sea, and the southern Chukchi Sea (Mizroch, Rice, and Breiwick, 1984) (see details provided below

for Gulf of Alaska, the Bering Sea, and Arctic) (Fig. III.B-5). The summer southern range in the eastern North Pacific extends as far south to about 32° N., and rarely, even farther south off Mexico. During the historic whaling period, “summer” concentration areas included, but were not limited to, the Bering Sea-eastern Aleutian Ground (60° N.-70° N. latitude, 175° E.-180° E. longitude, plus 45° N.-65° N. latitude, 180°-165° W. longitude) and the Gulf of Alaska Ground (also called the Northwest Coast Ground) (45° N.-55° N. latitude, 165° W.-160° W. longitude, 45° N.-60° N. latitude, 160° W.-134° W. longitude), and the Vancouver Ground (40° N.-55° N. latitude, 134° W.-125° W. longitude) (Mizroch et al., In prep.). Mizroch et al.’s (In prep.) summary indicates that the fin whales range across the entire North Pacific from April to October, but in July and August concentrate in the Bering Sea-eastern Aleutian area. In September and October, sightings indicate that fin whales are in the Bering Sea, the Gulf of Alaska, and along the U.S. coast as far as Baja California (in October) (Mizroch et al., In prep.).

Most fin whales are believed to migrate seasonally from relatively low latitude winter habitats where breeding and calving take place to relatively high latitude summer feeding habitats (Perry, DeMaster, and Silber, 1999a). The degree of mobility of local populations, and perhaps individuals, differs, presumably in response to patterns of distribution and abundance of their prey (Reeves et al., 1991; Mizroch et al., In prep.). Some populations migrate seasonally up to thousands of kilometers, whereas others are resident in areas with adequate prey (Reeves et al., 1999). Data from marked fin whales indicate that at least some individuals make long movements between wintering areas off Mexico and California to summer feeding areas in the Gulf of Alaska (Mizroch et al., In prep.). Angliss and Lodge (2005) reported that fin whales in the North Pacific generally are reported off the North American coast and Hawaii in winter and in the Bering Sea in summer. Passive acoustic data (McDonald and Fox, 1999) document that Hawaii is used in the winter by fin whales but indicate that densities are likely lower than those in California (Barlow, 1995; Forney, Barlow, and Carretta, 1995).

The importance of specific feeding areas to populations or subpopulations of fin whales in the North Pacific is not understood. In the North Atlantic, 30-50 % of identified individual fin whales returned to specific feeding areas in subsequent years (Clapham and Seipt, 1991). The timing of arrival at feeding habitats can vary by sex and reproductive status, with pregnant females arriving earlier (Mackintosh, 1965). Reeves, Silber, and Payne (1998) reported that fin whales tend to feed in summer at high latitude and fast, or feed little at winter lower latitude habitats. During visual cetacean surveys in July and August 1999 in the central Bering Sea, “...aggregations of fin whales were often sighted in areas where the...echo sounder...identified large aggregations of zooplankton, euphausiids, or fish” (Angliss, DeMaster, and Lopez, 2001:160).

III.B.4.a(2)(e)1 Use of the Arctic Ocean. Available information suggests that the summer range of the fin whale extends as far as the Chukchi Sea (Rice, 1974) (see Angliss and Outlaw, 2005:rev. 10/24/04, Fig. 40), including portions of the western Chukchi along the Chukotsk Peninsula and areas of the Alaskan Chukchi just north of the Bering Strait. Mizroch et al. (In prep.:14) reported “(T)hey regularly pass through the Bering Strait into the southwestern Chukchi Sea during August and September. They cite Zenkovich, a Russian biologist who wrote that in the 1930’s (quoted in Mizroch et al., In prep.) “...areas near Cape Dezhnev” are “...frequented by large schools (literally hundreds...) of fin whales...” and who also reported that fin whales were “encountered from early spring to the beginning of winter.” They report that Sleptsov (1961, cited in Mizroch et al., In prep.:14) wrote that fin whales occur “from the Bering Strait to the Arctic ice edge, in the coastal zone as well as the open sea. It...prefers areas free of ice, but also occurs in pools of open water among ice floes.” In more recent cruises (1979-1992) no fin whales were found in the Chukchi Sea or north of the Gulf of Anadyr (Vladimirov, 1994, as cited in Mizroch et al., In prep.). The southwestern Chukchi was probably a feeding area for fin whales. Information is not available to us that would permit evaluation of the current use of this area by fin whales.

Mizroch et al. (In prep.) summarized that there have only been rare observations of fin whales into the eastern half of the Chukchi. Three (including a mother and calf) fin whales were observed together in the southern Chukchi at 67° 10.5’ N. latitude, 168°44.8’ W. longitude directly north of the Bering Strait in July 1981 (Ljungblad et al., 1982). No other sightings of fin whales were reported during aerial surveys of endangered whales in summer (July) and autumn (August, September and October) of 1979-1987 in the Northern Bering Sea (from north of St. Lawrence Island), the Chukchi Sea north of 66° N. latitude and east of the International Date Line, and the Alaskan Beaufort Sea from 157° 01’ W. longitude east to 140° W. longitude and offshore to 72° N. (Ljungblad et al., 1988). Mizroch et al. (In prep.:15) summarized that “No

other sightings...of fin whales have ever been reported from the coast of Arctic Alaska....” They have not been observed during annual aerial surveys of the Beaufort Sea conducted in September and October from 1982-2004 (e.g., Treacy, 2002; Moore, DeMaster, and Dayton, 2000).

As with the fin whale, continued climate change could result in changes in oceanographic conditions, the distribution of humpback prey species, and the distribution of humpback whales. This possibility requires periodic consideration with regards for the potential of oil and gas activities within the Chukchi Sea, to affect this species.

III.B.4.a(2)(e) Foraging Ecology and Feeding Areas. Nemoto and Kasuya (1965) reported that fin whales feed in shallow coastal areas and marginal seas in addition to the open ocean. Citing the IWC (1992), Perry, DeMaster, and Silber (1999a) reported that there is great variation in the predominant prey of fin whales in different geographical areas, depending on which preys are locally abundant. While they “depend to a large extent on the small euphausiids” (see also Flinn et al., 2002) “and other zooplankton” (Perry, DeMaster, and Silber, 1999a:49), reported fish prey species in the Northern Hemisphere include capelin, *Mallotus villosus*; herring *Clupea harengus*; anchovies, *Engraulis mordax*; sand lance, *Ammodytes spp* (Perry, DeMaster, and Silber, 1999a); and also octopus, squid, and ragfish (Flinn et al., 2002). Stomach-content data from whales killed during commercial whaling in the 1950’s and 1960’s, (Nemoto and Kasuya, 1965) indicated that in the Gulf of Alaska, *Euphausia pacifica*, *Thysanoessa inermis*, *T. longipes*, and *T. spinifera* are the primary prey of fin whales. Mizroch et al. (In prep.) summarized fish, especially capelin, Alaska pollock, and herring are the main prey north of 58° N. latitude in the Bering Sea. Reeves, Silber, and Payne (1998) reported the above species as primary prey in the North Pacific and also listed large copepods (mainly *Calanus cristus*), followed by herring, walleye pollock (*Theragra chalcogramma*), and capelin. Mizroch et al. (In prep.) summarize that fin whales appear to be able to make long-distance movements quickly to track prey aggregations and can switch their diet from krill to fish as they migrate northward. They aggregate where prey densities are high (Piatt and Methven, 1992; Piatt et al., 1989; Moore et al., 1998, 2002). Often these are areas with high phytoplankton production and along ocean fronts (Moore et al., 1998). Such areas often are, in turn, associated with the continental shelf and slope and other underwater geologic features such as seamounts and submarine canyons (Steele, 1974; Boehlert and Genin, 1987; Dower, Freeland, and Juniper, 1992; Moore et al., 1998).

III.B.4.a(3) Humpback Whale (Central and Western North Pacific Stocks). The humpback whale is a medium-sized baleen whale that inhabits a wide range of ocean habitats, including some documented use of the Chukchi Sea. Available information does not indicate that humpback whales typically occur, or have been documented to occur, within either the Chukchi Sea Planning Area.

III.B.4.a(3)(a) ESA Status. The IWC banned commercial hunting of humpbacks in the Pacific Ocean in 1965 (Perry, DeMaster, and Silber, 1999b). Humpback whales were listed in 1973 as endangered under the ESA and as depleted under the MMPA. All stocks in U.S. waters are considered endangered (Perry, DeMaster, and Silber, 1999b, citing U.S. Dept. of Commerce, 1994b). All stocks of humpbacks are classified as “Protected Stocks” by the IWC. The NMFS published a Final Recovery Plan for the Humpback Whale in November 1991 (NMFS, 1991). On May 3, 2001, NMFS (66 FR 29502) published a final rule that established regulations applicable in waters within 200 nmi of Alaska that made it unlawful for a person subject to the jurisdiction of the U.S. to approach, by any means, within 100 yards (91.4 m) of a humpback whale. To prevent disturbance that could adversely affect humpbacks and to reduce threats from whale watching activities, NMFS also implemented a “slow, safe speed” requirement for vessels transiting near humpbacks. Exemptions to the rule were for commercial-fishing vessels during the course of fishing operations; for vessels with limited maneuverability; and for State, local, and Federal vessels operating in the course of official duty.

III.B.4.a(3)(b) Population Structure and Current Stock Definitions. There is “no clear consensus” (Calambokidis et al., 1997:6) about the population stock structure of humpback whales in the North Pacific due to insufficient information (Angliss and Lodge, 2002) (see further discussion in USDO, MMS, 2003a,b). For management purposes, the IWC lumps all humpback whales in the North Pacific Ocean into one stock (Donovan, 1991).

Recently, NMFS (Angliss and Lodge, 2002; Angliss and Outlaw, 2005) concluded that, based on aerial, vessel, and photo-identification surveys, as well as genetic analyses, there are at least three populations

within the U.S. Exclusive Economic Zone that move seasonally between winter/spring calving and mating areas and summer/fall feeding areas:

1. a California/Oregon/Washington and Mexico stock;
2. a Central North Pacific stock, which spends the winter/spring in the Hawaiian Islands and migrates seasonally to northern British Columbia, Southeast Alaska, Prince William Sound, and west to Unimak Pass; and
3. a western North Pacific Stock, which spends the winter/spring in Japan and migrates to spend summer and fall to areas west of Unimak Pass (the Bering sea and Aleutian Islands) and possibly to the Gulf of Anadyr (NMML unpublished data, cited in Angliss and Lodge, 2004).

There is no conclusive information on what population those humpbacks that enter the Chukchi Sea belong to. Based on the breakdown presented above, however, it is most likely that these whales would belong to the Western North Pacific stock.

III.B.4.a(3)(c) Past and Current Population Abundance in the North Pacific. The reliability of pre- and postexploitation and of current abundance estimates is uncertain. Based on whaling records (Perry, DeMaster, and Silber, 1999b), Rice (1978b) estimated there were above 15,000 humpbacks in the North Pacific prior to commercial exploitation. It is known that Soviet whalers under-reported their takes of certain species of whales in the North Pacific (Yablokov, 1994). Johnson and Wolman (1984) and Rice (1978) made reported rough estimates of 1,200 and 1,000, respectively, of the numbers of humpback surviving in the North Pacific after the cessation of commercial whaling for humpbacks in 1966. Perry, DeMaster, and Silber (1999b) caution that it is unclear whether these estimates are for the entire North Pacific or only the eastern North Pacific. With respect to the estimate of Johnson and Wolman and another postexploitation estimate of 1,400 by Gambell (1976), Calambokidis et al. (1997) concluded that "...the methods used for these estimates are uncertain and their reliability questionable."

Calambokidis et al. (1997) estimated the abundance of humpback whales in the mid-1990s in the wintering areas to be as follows: 394 (CV = 0.084) for the Western North Pacific Humpback whale stock; 4,005 (CV = 0.095) for the entire Central North Pacific stock on the wintering grounds in Hawaii; and about 1,600-4,200 for Mexico. Based on aerial surveys of the Hawaiian Islands, Mobley et al. (2001) estimated abundance in 2000 to be 4,491 (95% CI = 3,146-5,836) with an estimated rate of increase of 7% for the period 1993-2000). Based on surveys in the eastern Bering Sea in 2000, Moore et al. (2002) provided an abundance estimate of 102 (95% CI = 40-262). In the central Bering Sea, 315 individual humpbacks have been identified in Prince William Sound between 1977-2001 (von Ziegesar et al., 2004, as cited in Angliss and Lodge, 2004). Waite et al. (1999) estimated that the annual abundance of humpbacks in the Kodiak area to be 651 (95% CI: 356-1,523). Based on mark-recapture estimates of humpbacks to the west of Kodiak, Witteveen, Wayne, and Quinn (2005) estimated 410 (95% CI = 241-683) humpbacks in this area. Straley, Quinn, and Gabriele (2002) estimated that the abundance of humpback whales in Southeast Alaska is 961. Angliss and Outlaw (2005) stated that: "There are no reliable estimates for the abundance of humpback whales at feeding areas for this stock" (the Western North Pacific Stock) "because surveys of the known feeding areas are incomplete, and because not all feeding areas are known."

There are not conclusive or reliable data on current population trends for the western North Pacific stock (Perry, DeMaster, and Silber, 1999b; Angliss and Outlaw, 2005). However, based on aerial surveys on the wintering grounds in Hawaii during 1993-2000, Mobley et al. (2001) estimated that the Central North Pacific stock is increasing by about 7% annually.

Angliss and Outlaw (2005) provided a Potential Biological Removal (PBR) of 1.3 and 12.9 animals for the Western North Pacific Humpback Whales population and the entire Central North Pacific Stock, respectively. The PBR for the Western North Pacific stock is based on the conservative minimum population estimate of 367 for this stock. Angliss and Outlaw (2005) provided a PBR of 9.9 for the northern portion of the Central North Pacific stock and 3.0 animals for the Southeast Alaska portion.

Based on the estimates for the three wintering areas, Calambokidis et al. (1997) reported that their best estimate for humpbacks in the North Pacific was 6,010 (SE \pm 474). Adjusting for the effects of sex bias in their sampling and use of the higher estimate for Mexico yielded an estimate of about 8,000 humpback whales in the North Pacific. Perry, DeMaster, and Silber (1999b) concluded that the Calambokidis et al. (1997) estimate of about 6,000 probably was too low.

III.B.4.a(3)(d) Reproduction, Survival and Nonhuman-Related Sources of Mortality. Humpbacks give birth and presumably mate in their wintering ground. Perry, DeMaster, and Silber (1999b) summarized that calving occurs along continental shelves in shallow coastal waters and off some oceanic islands (e.g., Hawaii). Calving in the Northern Hemisphere takes place between January and March (Johnson and Wolman, 1984). Information about age of sexual maturity is of uncertain reliability (Perry, DeMaster, and Silber, 1999b). While calving intervals vary substantially, most female humpbacks typically calve at 1- to 2-year intervals (Glockner-Ferrari and Ferrari, 1990; Straley, 1994). Gestation is about 12 months, and calves probably are weaned after about a year (Rice, 1967; Perry, DeMaster, and Silber, 1999b).

Causes of natural mortality in humpbacks in the North Pacific are relatively unknown, and rates have not been estimated. There are documented attacks by killer whales on humpbacks, but their known frequency is low (Whitehead, 1987; Perry, DeMaster, and Silber, 1999b). Lambertsen (1992) cited giant nematode infestation as a potential factor limiting humpback recovery.

III.B.4.a(3)(e) Migration, Distribution, and Habitat Use. Humpback whales range throughout the world's oceans, with lower frequency use of Arctic waters (Perry, DeMaster, and Silber, 1999b; Angliss and Lodge, 2002, 2005). Knowledge of their movements and the interrelations of individuals seen on different summer feeding grounds and those on different winter calving/breeding grounds is based on the recovery of whaling records about harvest locations, discovery marks used in commercial-whaling operations, photoidentification, genetic analyses, and comparison of songs (Perry, DeMaster, and Silber, 1999b). In the North Pacific each year, most (but not all individuals in all years) humpbacks undergo a seasonal migration from wintering habitats in tropical and temperate regions (10°-23° N. latitude), where they calve and mate, to more northern regions, where they feed on zooplankton and small schooling fish species in coastal and inland waters from Point Conception, California, to the Gulf of Alaska and then west along the Aleutian Islands, the Bering Sea, the Amchitka Peninsula and to the southeast into the Sea of Okhotsk (Angliss and Lodge, 2002, 2005; Nemoto, 1957) (Fig. III.B-6). During the period of commercial whaling, there are reports of this species in the southwestern Chukchi Sea. Feeding areas tend to be north of about 30° N. latitude, along the rim of the Pacific Ocean basin from California to Japan. In the most recent draft stock assessment for the western North Pacific stock, NMFS (as reported by Angliss and Outlaw, 2005) summarized that: "...new information...indicates that humpback whales from the western and Central North Pacific stocks mix on summer feeding grounds in the central Gulf of Alaska and perhaps the Bering Sea." Individuals tend not to move between feeding areas. Mizroch et al. (2004) summarized that, based on all sightings, <2% of all individuals sighted were observed in more than one feeding area.

III.B.4.a(3)(e)1 Use of Arctic Ocean. The NMFS (1991) (citing Nikulin, 1946 and Berzin and Rovin, both in Russian), summarized that the northern Bering Sea, Bering Strait, and southern Chukchi Sea along the Chukchi Peninsula are the northern extreme of the range of the humpback (see also Johnson and Wolman, 1984). However, neither Figure 38 of the most recent stock assessment for the Western North Pacific stock nor Figure 39 for the central North Pacific stock (Angliss and Outlaw-2005) depict the Chukchi Sea as part of the "approximate distribution" of humpback whales in the North Pacific. There are other references that indicate that both the historical and current summer feeding habitat of the humpback included, and at least sometimes includes, the southern portion, especially the southwestern portion, of the Chukchi Sea. Mizroch et al. (In prep.:14) cited Zenkovich, a Russian biologist who wrote that in the 1930's (quote in Mizroch et al., In prep.) "The Polar Sea, in areas near Cape Dezhnev...is frequented by large schools (literally hundreds...) of fin whales, humpbacks, and grays."

Available information does not indicate humpbacks inhabit northern portions of the Chukchi Sea or enter the Beaufort Sea. No sightings of humpback whales were reported during aerial surveys of endangered whales in summer (July) and autumn (August, September, and October) of 1979-1987 in the Northern Bering Sea (from north of St. Lawrence Island), the Chukchi Sea north of 66° N. latitude and east of the International Date Line, and the Alaskan Beaufort Sea from 157° 01' W. longitude east to 140° W. longitude and offshore to 72° N. latitude (Ljungblad et al., 1988). They have not been observed during annual aerial surveys of the Beaufort Sea conducted in September and October from 1982-2004 (e.g., Monnett and Treacy, 2005; Moore et al., 2000; Treacy, 2002). Recently, during a research cruise in which all marine mammals observed were recorded from July 5 to August 18, 2003, in the Chukchi and Beaufort seas, no humpback whales were observed (Bengtson and Cameron, 2003).

III.B.4.a(3)(e)2 Feeding Behavior. Humpbacks tend to feed on summer grounds and to not eat on winter grounds (Fig. III.B-6). Some low-latitude winter feeding has been observed and is considered opportunistic (Perry, DeMaster, and Silber, 1999b). They engulf large volumes of water and then filter small crustaceans and fish through baleen plates. They are relatively generalized in their feeding. In the Northern Hemisphere, known prey includes: euphausiids (krill); copepods; juvenile salmonids, *Oncorhynchus* spp.; Arctic cod, *Boreogadus saida*; walleye pollock, *Theragra chalcogramma*; pollock, *Pollachius virens*; pteropods; and cephalopods (Johnson and Wolman, 1984; Perry, DeMaster, and Silber, 1999b). Bottom feeding recently has been documented in humpbacks off the east coast of North America (Swingle, Barcho, and Pichford, 1993). Within a feeding area, individuals may use a large part of the area. Two individual humpbacks sighted in the Kodiak area were observed to move 68 km (~42.25 mi) in 6 days and 10 km (~6.2 mi) in 1 day, respectively (Waite et al., 1999). In the Kodiak Archipelago, winter aggregations of humpbacks were frequently observed at the head of several bays where capelin and herring spawn (Witteveen, Wynne, and Quinn, 2005), a pattern similar to that reported to Southeast Alaska where sites occupied in the winter are coincident with areas that have overwintering herring.

III.B.4.b. Threatened and Endangered Marine and Coastal Birds.

Threatened and endangered species in the Chukchi Sea Planning Area include the spectacled eider (threatened), Steller's eider (threatened), and Kittlitz's murrelet (candidate species). These species are known to seasonally occur in the Chukchi Sea OCS. The MMS initiated consultation with the FWS by requesting a list of threatened and endangered species present in the Chukchi Sea OCS Planning Area. The FWS responded with their determination of threatened and endangered and candidate species, and listed Steller's and spectacled eiders and the candidate Kittlitz's murrelet as occurring in the Chukchi Sea Planning Area. A biological evaluation for candidate species, such as the Kittlitz's murrelet, is not required under the ESA, however the Kittlitz's murrelet was treated as if it were listed as threatened or endangered in the event it becomes listed and for the purpose of minimizing potential negative effects the Proposed Action could have on this species.

The description of these species is provided in the Biological Evaluation which due to its large size, is available at the mms website (http://www.mms.gov/alaska/ref/Biological_opinionsevaluations.htm) or from MMS. The description of these species in the BE from the draft EIS remains current.

III.B.5. Marine and Coastal Birds.

III.B.5.a. Affected Species and their Habitat.

Most birds that occur in the Chukchi Sea area do so on a seasonal basis. Arrival times usually coincide with the formation of leads during spring migration to coastal breeding areas. During spring migration, many seabirds (such as murres) and sea ducks (such as common eiders and long-tailed ducks) will closely follow leads that typically form along the edge of the landfast ice. Migration times vary between species, but spring migration for most species takes place between late March and late May. Many birds that breed on the North Slope migrate through the proposed sale area twice each year. Accordingly, North Slope breeding birds are vulnerable to impacts from oil and gas exploration and production activities, even though they breed outside the proposed sale area. Departure times from the Beaufort and Chukchi seas during postbreeding or fall migration vary between species and often by sex within the same species, but most marine birds will have moved out of the Chukchi Sea by late fall before the formation of sea ice.

III.B.5.b. Cliff-Nesting Seabirds.

III.B.5.b(1) Murres. Common murres (*Uria aalge*) and thick-billed murres (*U. lomvia*) breed as far north as Cape Lisburne. Approximately 100,000 murres nest at Cape Lisburne, of which about 70,000 are common murres (USDOI, FWS, 2005a). Farther south at Cape Thompson, there are about 390,000 nesting murres, 75% of which are thick-billed (Fadely et al., 1989). Long-term monitoring at Cape Thompson indicates a ~50% decline in murre numbers (species combined) since 1960, whereas the colony at Cape Lisburne has more than doubled between 1976 and 1995 (Fadely et al., 1989; Roseneau, 1996). Significant positive trends were evident for murres at Cape Lisburne (+4.7% per annum) (Dragoo, Byrd, and Irons, 2004), but Roseneau (2007) reported a decline in land-based plots there in subsequent years.

There are a few important aspects of murre breeding biology that are relevant to oil and gas development. Murres are typically long-lived and have a low reproductive rate (Gaston and Hipfner, 2000). Age at first breeding is between 5-7 years and only one egg is laid each year. Murres breed on cliffs and species in colonies often are intermingled. Murre colonies are quite large and birds appear to need the presence of a large number of other murres to be stimulated to breed (social facilitation; Ehrlich, Dobkin, and Wheye, 1988). If the colony is reduced in size below a certain (unknown) threshold, the colony is abandoned and can remain so for decades.

Murres are primarily piscivorous and rely on dispersed schools of offshore fish. During a study in the mid-1990's, Hatch et al. (2000) used satellite telemetry on a small number of murres from the two Chukchi Sea colonies. Based on the movement of these few murres, they concluded the foraging ranges of the murres from the two colonies were almost completely separate. The Cape Thompson colony foraged primarily southwest to southeast and north to Point Hope, whereas the Cape Lisburne colony foraged primarily northwest to northeast. These distributions were similar during the two summers of the study. Distances to foraging areas at Cape Lisburne for a thick-billed murre averaged 66 ± 26 km (range 47-84 km, $n = 2$ foraging bouts) and 79 ± 26 km (range 44-114, $n = 8$ foraging bouts) in a single common murre. These ranges were for likely breeders; failed breeders may range considerably farther. Areas regularly used for foraging covered an area of about 30,000 km². Based on these limited data, murre foraging areas overlap with the area considered in the proposed sale (Fig. III.B-7).

Hatch et al. (2000) also determined that breeding murres began to leave their colonies in early September. Most females flew south to the Bering Sea from the colonies. Males remained adrift in the Chukchi Sea (Fig. III.B-7), and it is thought that they remained with the flightless chicks. Because the chicks were not equipped with satellite transmitters, it was not possible to confirm this scenario. However, several researchers working in other areas have determined that only males care for flightless chicks at sea (Scott, 1973, 1990; Birkhead, 1976; Harris and Birkhead, 1985). The flightless period for juvenile murres at sea lasts from early September to the middle of November when they, along with attendant adult males, move quickly from the Chukchi Sea to winter locations in the Bering Sea. During part of this period at sea, male murres also molt and are flightless. While these murres were adrift they drifted north and west towards Siberia and averaged 15-20 km/day over a large area (Fig. III.B-7). As the murre distribution during this period (early September through mid-November) covers a large area of the Chukchi Sea, it is likely that there would be flightless murres using the proposed sale area in late summer and fall. This is a critical portion of their life cycle, because molting and foraging birds are vulnerable to both disturbances and spills and flightless individuals are not capable of undertaking large scale movements to other areas.

III.B.5.b(2) Puffins. The horned puffin (*Fratercula corniculata*) and the tufted puffin (*F. cirrhata*) are found in the Chukchi Sea area. Like many seabirds, puffins are typically long-lived and have a low reproductive rate (Ehrlich, Dobkin, and Wheye, 1988). Age at first breeding is between 5-7 years and only one egg is laid each year. Puffins breed in burrows in colonies.

Sowls, Hatch, and Lensink (1978) reported the horned puffin was the most abundant puffin species in the Chukchi Sea, where around 18,000 breed at colonies at Cape Lisburne and Cape Thompson. Numbers of horned puffins in the Chukchi Sea were greatest in the vicinity of Cape Lisburne after the breeding season in September. The current status of horned puffins in the Chukchi Sea is unknown.

Horned puffins are not obligate cliff nesters, and they can breed on suitable beach habitat on islands nearshore by digging burrows or hiding under large pieces of driftwood or debris. Horned puffins recently have been seen near Barrow and have started to breed (and kill black guillemot chicks) on Cooper Island in the western Beaufort Sea (Friends of Cooper Island, 2005).

Horned puffins are primarily piscivorous and rely on dispersed schools of offshore fish. In this way, horned puffins could be similar to murres, although the degree to which prey species/foraging areas overlap is unknown. Horned puffins at breeding colonies in other areas of Alaska have been reported to forage in excess of 100 km offshore (Hatch et al., 2000).

The current status of the tufted puffin in the Chukchi Sea is also unknown. Sowls, Hatch, and Lensink (1978) reported about 100 tufted puffins breeding at small colonies between Cape Thompson and Cape

Lisburne. As an obligate cliff nester, the range of the tufted puffin would not be expected to expand farther northward, as cliff habitats are limited.

III.B.5.b(3) Black-Legged Kittiwake. The current status of the black-legged kittiwake (*Rissa tridactyla*) in the Chukchi Sea is unknown. The center of the North Pacific breeding range for black-legged kittiwakes is in the Gulf of Alaska and the Bering Sea (Sowls, Hatch, and Lensink, 1978). Breeding colonies in the Chukchi Sea (Cape Thompson and Cape Lisburne) are at the northern limit of their breeding range in Alaska. Data collected between 1960 and 1978 reported approximately 48,000 black-legged kittiwakes bred along the Chukchi Sea coast between Cape Thompson and vicinity to Cape Lisburne (USDOJ, FWS, 2005a).

Divoky (1987) reported black-legged kittiwakes were abundant from mid-July until late September where they range far offshore in the Chukchi Sea north of Cape Thompson through most of the area considered for the lease sale. Divoky (1987) estimated over 400,000 black-legged kittiwakes in the pelagic Chukchi Sea. The portion of this population in the proposed lease sale area is unknown, but could be substantial late in the open-water season. Seasonal areas of concentration, if any, are unknown.

III.B.5.c. Bering Sea Breeders and Summer Residents.

III.B.5.c(1) Northern Fulmar. The current status of the northern fulmar (*Fulmarus glacialis*) is unknown. Fulmars do not breed along the Chukchi Sea coast, and those observed in this area during the spring and summer are nonbreeders or failed breeders from southern areas. Divoky (1987) estimated 45,000 northern fulmars in pelagic waters of the Chukchi Sea (typically south of Cape Lisburne) during late August to mid-September, but this number is relatively small compared with an estimated 2.1 million that are present in the Bering Sea in the summer (Gould, 1983).

III.B.5.c(2) Short-Tailed Shearwater. The current status of the short-tailed shearwater (*Puffinus tenuirostris*) in the Chukchi Sea is unknown. These birds breed in the Southern Hemisphere. Short-tailed shearwaters are found primarily in the Bering Sea during the nonbreeding period. Short-tailed shearwaters in the Chukchi Sea are most common in the southern portion, although they are routinely found in the proposed sale area. Short-tailed shearwaters are most common in the Chukchi Sea from late August to late September.

Hunt et al. (1981) estimated the population in the northern hemisphere was between 20 and 30 million birds in 1981. Divoky (1987) reported short-tailed shearwaters as far north as Barrow and into arctic Canada. In certain years, an estimated 100,000 short-tailed shearwaters passed Point Barrow in one day in mid-September (Divoky, 1987). This observation with is consistent with those of Bailey (1948).

At northern latitudes, short-tailed shearwaters likely forage on dense patches of euphausiids and amphipods.

III.B.5.c(3) Auklets. The current status of parakeet (*Cyclorhynchus psittacula*), least (*Aethia pusilla*) and crested (*A. cristatella*) auklets in the Chukchi Sea is unknown. In 1986, an anomalous year due to a large intrusion of Bering Sea water into the Chukchi Sea that likely affected zooplankton availability, crested auklets were abundant in the Chukchi Sea. From late August until early October 1986 there were probably well over 100,000 crested auklets in the Chukchi Sea, the most numerous auklet species during this period. Divoky (1987) suggested the distribution in other years is probably patchier with fewer birds, perhaps a total of 100,000 auklets when combining the three species. All breed as far north as the Bering Strait (Sowls, Hatch, and Lensink, 1978), but move into the Chukchi Sea, including much of the proposed lease sale area from late August into early October.

III.B.5.d. High Arctic-Associated Seabirds.

III.B.5.d(1) Black Guillemot. The current status of the black guillemot (*Cepphus grylle*) in the Chukchi Sea is unknown. Roseneau and Herter (1984) estimated 500 breeding birds in the Alaskan Chukchi Sea ranging from Cape Thompson northward. Despite the relatively small breeding population in Alaska (the Chukchi and Beaufort seas have a combined total of fewer than 2,000 birds), the pelagic population in the Chukchi Sea is estimated to be around 70,000 (Divoky, 1987). It may be that the Alaska breeding and

nonbreeding populations combine with the small (~300) Russian Chukchi population and the large (~40,000) nonbreeding population of the eastern Siberian Sea to forage during the summer near the decomposing ice edge in the northern Chukchi Sea (Golovkin, 1984).

Black guillemots remain closely associated with sea ice throughout their lifetime, where they feed extensively on arctic cod (*Boreogadus saida*) (Divoky, 1987). The largest breeding colony in the Beaufort Sea is on Cooper Island, where breeding occurs between late June and early September. Cooper Island is located east of the boundaries for the proposed lease sale area. These guillemots make frequent foraging trips to the ice edge to forage on arctic cod; therefore, in the Beaufort Sea they are common within their foraging range from Cooper Island. When the sea ice is beyond their foraging range, it appears that black guillemots switch prey to other fish species (Friends of Cooper Island, 2005).

Black guillemots that breed on Cooper Island in the Beaufort Sea also make use of the Chukchi Sea in the vicinity of Point Barrow during the early part of the breeding season (Divoky, 1987). Peard Bay was particularly important to nesting black guillemots (Kinney, 1985).

III.B.5.d(2) Ross' Gull. The boundaries for the proposed sale area include an area near Point Barrow where Ross' gulls (*Rhodostethia rosea*) may be encountered. These gulls are rare in the Beaufort Sea during summer, because most breed in coastal areas in the Russian Arctic. Ross' gulls have been found breeding in Nunavut, Canada on an irregular and scattered basis (Bechet et al., 2000). When present during summer in the Beaufort Sea, Ross' gulls are typically found in close association with the ice edge. In September and October, Ross' gulls are common migrants in the western Beaufort Sea, where they occur in greatest concentrations between Point Barrow and Tangent Point (near the eastern edge of Elson Lagoon) (Divoky et al., 1988). These few weeks in fall are the only time that Ross' gulls are visible nearshore in Alaska. These birds do not overwinter in the Arctic Ocean as once thought, and many migrate south through the Chukchi Sea and pass through the Bering Strait to winter in the Bering Sea from St. Lawrence Island south along the Kamchatka Peninsula to the Sea of Okhotsk (Divoky et al., 1988).

III.B.5.d(3) Ivory Gull. The current status of the ivory gull (*Pagophila eburnea*) in the Chukchi Sea is unknown. Divoky (1987) reported that ivory gulls are closely associated with the ice edge throughout their lifecycle. Ivory gulls are considered uncommon to rare in pelagic waters of the Chukchi during summer, and small numbers migrate through in fall to wintering areas in the northern Bering Sea.

III.B.5.d(4) Arctic Tern. The current status of the Arctic tern (*Sterna paradisaea*) in the Chukchi Sea is unknown. Divoky (1983) observed that arctic terns were rare in the pelagic waters of the Chukchi Sea. Dau and Larned (2005) observed more than 600 Arctic terns between Omalik Lagoon and Point Barrow, with the majority located in Kasegaluk Lagoon. In Kasegaluk Lagoon, Johnson, Wiggins, and Wainwright (1992) found Arctic terns were more abundant and widespread than similar areas in Beaufort Sea. While common in pelagic waters of the Pacific Ocean on their migration to and from the Southern Hemisphere, they likely follow a more coastal route out of the Chukchi Sea in fall. During aerial surveys of Kasegaluk Lagoon in late July and August in 1990 and 1991, Johnson, Wiggins, and Wainwright (1992) observed nearly 3,900 Arctic terns, many of which were presumed to be migrants.

III.B.5.e. Tundra-Breeding Migrants.

III.B.5.e(1) Jaegers. The current status of jaegers in the Chukchi Sea is unknown. All three species of jaegers (*Stercorarius pomarinus*, *S. parasiticus*, and *S. longicaudus*) were considered common in the Chukchi Sea in summer until late September, when they moved south to the Bering Sea (Divoky 1987). Jaeger densities at sea were thought to be higher in years when there was low breeding effort on the tundra. Between late July and late August, Divoky (1987) estimated 100,000 jaegers in the Chukchi Sea. Jaegers were dispersed throughout pelagic areas of the Chukchi Sea, with no obvious concentration areas.

III.B.5.e(2) Glaucous Gull. The current status of the glaucous gull (*Larus hyperboreus*) in the Chukchi Sea is unknown. Most glaucous gulls breed inland near freshwater, but some breed at coastal seabird colonies (Divoky, 1987; SOWLS, Hatch, and Lensink, 1978). Glaucous gulls were most common in the Chukchi Sea from late July to late September within 70 km of shore between Icy Cape and Barrow. Glaucous gulls typically occur in low densities in the Chukchi Sea, but commonly congregate at food sources (Divoky, 1987).

Dau and Larned (2005) observed more than 2,200 glaucous gulls between Omalik Lagoon and Point Barrow, with the majority located between Omalik Lagoon and the northern edge of Kasegaluk Lagoon. During aerial surveys of Kasegaluk Lagoon in late July, August, and September from 1989-1991, Johnson, Wiggins, and Wainwright (1992) observed as many as 6,000 glaucous gulls. On most surveys, several hundred to about 3,000 glaucous gulls were encountered, but the high count of about 6,000 glaucous gulls was observed on a day when gulls were concentrated near several dozen beluga whale carcasses close to Point Lay. Point Lay is the site of a large, annual beluga whale subsistence harvest.

III.B.5.f. Waterfowl.

III.B.5.f(1) Loons. Pacific loons (*Gavia pacifica*) are the most common loon species migrating along the Chukchi Sea coast, although red-throated (*G. stellata*) and yellow-billed loons (*G. adamsii*) are present in fewer numbers. In spring, loons typically migrate along coastal routes, although some may migrate using inland routes (Johnson and Herter, 1989). Most loons migrate very close to shore during fall migration until they reach the Lisburne Peninsula, where they head farther out to sea to head towards the Bering Strait (Divoky 1987). Most of the postbreeding loon migration takes place in September and, although loons may stop to rest, they are most commonly observed in flight as they migrate to southern locations for the winter.

Across the Arctic Coastal Plain, the red-throated loon population index remained well below average with a significant long-term negative growth rate (0.941 where 1.0 is stable). However, red-throated loons have had a relatively stable trend for the past 7 years (Larned, Stehn, and Platte, 2005). Red-throated loons nest on smaller ponds than yellow-billed or Pacific loons. This may be a reproductive strategy to allow for earlier nest initiation, because shallow, small ponds become free of ice sooner than large ponds (Johnson and Herter, 1989).

Compared to what is known about yellow-billed loons near the Beaufort Sea coast, there is very little known about the coastal areas bordering the Chukchi Sea. Of the approximately 3,300 yellow-billed loons present on the breeding grounds on the North Slope, primarily between the Meade and Colville rivers in the National Petroleum Reserve-Alaska (NPR-A), it is likely that there are fewer than 1,000 nesting pairs, because some of the ~3,300 are nonbreeders. Additionally, there are approximately 1,500 yellow-billed loons, presumably juvenile nonbreeders, which remain in nearshore marine waters or in large rivers during the breeding season. In total, there are fewer than 5,000 yellow-billed loons on the North Slope breeding grounds and nearshore marine habitat (Earnst et al., 2005).

Yellow-billed loons typically nest near large, deep, tundra lakes where they nest on low islands or near the edges of lakes to avoid terrestrial predators (Johnson and Herter, 1989). Johnson, Wiggins, and Wainwright (1992) reported densities of fewer than 0.01 birds/km² in Kasegaluk Lagoon during aerial surveys from 1989-1991. Over the 3 years, there were only 20 yellow-billed loons observed during these aerial surveys. These low numbers are not surprising given that these aerial surveys were conducted in July through September and were only conducted over the lagoon, not tundra, habitat. Similarly, Dau and Larned (2005) observed only 23 yellow-billed loons during a late June survey of the coast and barrier islands between Omalik Lagoon and Point Barrow. This survey did not include terrestrial habitat. Larned, Stehn, and Platte (2005) surveyed terrestrial habitat on the Arctic Coastal Plain as part of the eider breeding population survey. In 2005, the yellow-billed loon population index was above the long-term average and continued an erratic pattern and slight, though nonsignificant, upward trend. These low numbers, patchy distributions, and specific habitat requirement may make yellow-billed loons more susceptible to environmental perturbations such as disturbance, habitat alterations, and oil spills than species that are more abundant and widely distributed and that are able to exploit a greater diversity of habitats (Hunter, 1996).

The Center for Biological Diversity (CBD) petitioned the FWS to list the yellow-billed loon as an endangered or threatened species under the ESA on March 30, 2004 (CBD, 2004). The petition identifies threats to the species as oil and gas development, human disturbance, increased predation, small population size and low productivity, marine health, incidental by-catch from fishing, hunting, and the inadequacy of existing regulatory mechanisms. It appears the FWS will not issue a 90-day finding on the CBD petition but will work with local, State, and Federal resource agencies on a Conservation Agreement for the yellow-billed loon (YBLO). The goal of the Conservation Agreement is to "... protect YBLO and their breeding, brood-rearing, and migrating habitats in Alaska, such that current or potential threats in these areas are

avoided, eliminated or reduced to the degree that the species will not become threatened or endangered from these threats within the foreseeable future."

III.B.5.f(2) Long-Tailed Duck. The long-tailed duck (*Clangula hyemalis*) is a common species in the Chukchi Sea after the first week of September until late October. Typical migration distances offshore for long-tailed ducks, as well as other species, are shown in Figure III.B-8. While most migrate within 45 km of shore (roughly along the 20-m isobath), infrequent observations of long-tailed ducks in pelagic waters occur in late September (Divoky, 1987). Many long-tailed ducks molt in Kasegaluk Lagoon and Peard Bay on the Chukchi Sea coast (Johnson, Frost, and Lowry, 1992; Kinney, 1985). During aerial surveys in 1989-1991, long-tailed ducks were abundant in Kasegaluk Lagoon, second only to black brant. As many as 9,093 long-tailed ducks were observed during a single survey of Kasegaluk Lagoon. Many of these birds were found in the middle of the lagoon or near the barrier islands on the lagoon side (Johnson, Frost, and Lowry, 1992).

Molting long-tailed ducks tend to stay in or near the lagoons, especially near passes between the lagoon and the sea (Johnson, Wiggins, and Wainwright, 1992). Brackney and Platte (1986) observed long-tailed ducks feeding heavily in passes between barrier islands (Lysne, Mallek, and Dau, 2004).

III.B.5.f(3) Common Eider. During spring migration, the common eider (*Somateria mollissima*) typically migrates along the Chukchi Sea coast, using offshore open-water leads. Offshore migration distances are poorly understood for the Chukchi Sea, but in the Beaufort Sea they are usually found within 48 km (29 mi) of shore. The spring lead system is particularly important to common eiders during this period. Recent information on king eiders may be applicable to common eiders. Opper (2007, pers. commun.) reported extensive use of the spring lead system by king eiders. According to Opper, 80 king eiders were satellite-tagged between 2002 and 2006. Of these, 23 died or the transmitter failed. Of the remaining 57 birds, 54 (95%) were documented to stage during the spring in the Ledyard Bay vicinity (nearshore waters between Cape Lisburne and Peard Bay). The typical staging time of king eiders in Ledyard Bay was 17-24 days (range 1- 48 days).

Common eiders nest on barrier islands or spits along the Chukchi Sea coast (Johnson and Herter, 1989). During a 2005 aerial survey conducted in late June to coincide with the common eider egg laying and early incubation period, 742 common eiders were observed in along the Chukchi Sea coast between Omalik Lagoon and Point Barrow. Most common eiders were observed in Kasegaluk Lagoon and Peard Bay (Dau and Larned, 2005).

Beginning in late June, postbreeding male common eiders begin moving towards molting areas in the Chukchi Sea. In July and August, most common eiders in the Chukchi Sea are molting males. Adult female breeders migrate to molt locations in late August and September. Most breeding female common eiders and their young begin to migrate to molt locations in late August and September, although large numbers of female common eiders were observed molting in the eastern Beaufort Sea in Canada near Cape Parry and Cape Bathurst (Johnson and Herter, 1989). Johnson, Wiggins, and Wainwright (1992) observed between 1,125 and 2,031 common eiders in early September during aerial surveys in 1989 and 1990 during the molt period. Common molt areas in Alaskan waters in the Chukchi Sea are near Point Lay, Icy Cape, and Cape Lisburne (Johnson and Herter, 1989). The Peard Bay area was particularly important to molting eiders (Kinney, 1985).

After the molt is completed, some common eider move offshore into pelagic waters, but most eiders remain close to shore (Divoky, 1987). When traveling along the northwest coast of Alaska, these eiders tend to stay along the 20-m isobath, approximately 48 km (29 mi) from shore (Fig. III.B-8). Most males are out of the Beaufort Sea by late August or early September, and most females were gone by late October or early November. Most common eiders winter near the Bering Sea pack ice or near the Aleutian Islands, but some remain within open leads in the Chukchi Sea until early winter (Johnson and Herter, 1989).

The common eider population in the nearby Beaufort Sea declined by 53% between 1976 and 1996 (Suydam et al., 2000). Common eiders were surveyed in marine waters within 100 km of the Beaufort Sea shoreline between Barrow and Demarcation Point by Fischer and Larned (2004) during the summers 1999-2001. In general, common eiders were concentrated in shallow waters (<10 m), with the highest densities occurring in segments between Oliktok point and Prudhoe Bay and between Tigvariak Island and

Brownlow Point. Common eiders were most commonly associated with barrier islands in these segments, becoming less commonly observed up to 50 km seaward. Common eider densities were highest in areas of low ice cover.

Fischer and Larned (2004) concluded that because eider densities did not vary between summer months, the eiders they observed near barrier islands were local breeders rather than molt or fall migrants. This is consistent with Petersen and Flint (2002), who showed that satellite-tagged common eider hens remained in shallow waters close to their breeding sites through September.

Our most recent information still indicates that male common eiders begin moving out of the Beaufort Sea beginning in late June. Most males are out by late August or early September, and most females were gone by late October or early November. When traveling west along the Beaufort Sea coast, approximately 90% of the common eiders migrate within 48 km of the coast; 7% migrate 13-16 km from shore, roughly along the 17-20 m isobath (Johnson and Herter, 1989, citing Bartels, 1973).

III.B.5.f(4) King Eider. Most king eiders (*Somateria spectabilis*) begin to migrate through the Chukchi Sea during spring and arrive in the Beaufort Sea by the middle of May, with males typically preceding females (Barry, 1968). In the Beaufort Sea, the location and timing of offshore leads along the Chukchi Sea is a major factor determining routes and timing of king eider migration (Barry, 1986). The spring lead system is particularly important to king eiders during this period. Powell et al. (2005) reported that Ledyard Bay may be a critical stopover area for foraging and resting during spring migration. Opper (2007, pers. commun.) reported extensive use of the spring lead system by king eiders. According to Opper, 80 king eiders were satellite-tagged between 2002 and 2006. Of these, 23 died or the transmitter failed. Of the remaining 57 birds, 54 (95%) were documented to stage in the Ledyard Bay vicinity (nearshore waters between Cape Lisburne and Peard Bay). The typical staging time in Ledyard Bay was 17-24 days (range 1-48 days).

Most king eiders nesting on the North Slope between Icy Cape and the western boundary of the Arctic National Wildlife Refuge nested in three general areas: between the Colville River and Prudhoe Bay, southeast of Teshekpuk Lake, and a large area near Atkasuk (Larned, Stehn, and Platte, 2005). Dau and Larned (2005) surveyed the Chukchi coast during the common eider egg-laying and early incubation period and found fewer than 300 king eiders. These low numbers probably are because the common eider survey focused on the coast and barrier islands and most king eiders would be on tundra breeding grounds by late June.

Many male king eiders move to staging areas along the Chukchi Sea, including Ledyard Bay, in mid- to late July (Dickson, Suydam, and Balogh, 2000; Dickson, Balogh, and Hanlan, 2001). During a similar study, Powell et al. (2005) also found eiders staging in Ledyard Bay. Dickson, Suydam, and Balogh (2000) described the northern part of Ledyard Bay near Icy Cape as a staging area for king eiders during the fall. The Peard Bay area was also particularly important to molting eiders (Kinney, 1985).

Aerial surveys of king eiders conducted on the Arctic Coastal Plain during June 2006 yielded a population index of 12,896, which was below the 14-year mean of 13,070. The index also was below the 2005 index of 14,934 (Larned, Stehn, and Platte, 2006). The long-term (14 year) growth rate was 1.017 (Larned, Stehn, and Platte, 2006). The growth rate for the last 7 years is 0.986. Distributions during the 2006 surveys were similar to previous years.

Satellite telemetry was used to determine that most king eiders spent more than 2 weeks staging offshore in the Beaufort Sea prior to migrating to molt locations in the Bering Sea (Phillips, 2005; Powell et al., 2005). Female king eiders may need to remain in the Beaufort Sea longer than males to replenish fat stores depleted during egg laying and incubation (Powell et al., 2005). Prior to molt migration, king eiders in the Beaufort Sea usually were found about 13 km offshore; however, during migration to molting areas, king eiders occupied a wide area ranging from shoreline to >50 km offshore (Phillips, 2005).

The king eider population in the nearby Beaufort Sea appeared to remain stable between 1953 and 1976 but declined by 56% between 1976 and 1996 (Suydam et al., 2000). Fischer and Larned (2004) surveyed king eiders in marine waters within 100 km of the Beaufort Sea shoreline between Barrow and Demarcation Point during the summers 1999 and 2001. King eiders were the second most abundant species counted

during the survey periods. King eider densities varied according to water depth, offshore distance, and percent of ice cover. Large flocks of king eiders concentrated in the mid-depth- (10-20 m) zone offshore of Barrow and Oliktok Point. In 1999 and 2000, these flocks were in waters >10 m deep but were found in the shallow (<10 m) and mid-depth zone in July 2001. King eiders were unique among species surveyed by occurring in higher densities in low (31%) and moderate (31-60%) ice cover (Fischer and Larned, 2004).

Aerial surveys of king eiders conducted on the Arctic Coastal Plain during June 2006 yielded a population index of 12,896, which was below the 14-year mean of 13,070. The index also was below the 2005 index of 14,934 (Larned, Stehn, and Platte 2006). The long-term (14 year) growth rate was 1.017 (Larned, Stehn, and Platte, 2006). The growth rate for the last 7 years is 0.986. Distributions during the 2006 surveys were similar to previous years. Although reduced from population levels of the mid-1970s, the population has a significantly positive long-term (14 year) growth rate.

III.B.5.f(5) Pacific Brant. Although not known to nest near the Chukchi Sea coast in appreciable numbers, many brant (*Branta bernicla nigricans*) migrate along the west coast of Alaska enroute to breeding areas on the North Slope or to the Canadian High Arctic. Brant typically nest on offshore spits, barrier islands, or on islands formed in large river deltas. Brant normally do not nest farther inland than 40 km from the coast (Derksen, Rothe, and Eldridge, 1981). During a 2005 aerial survey conducted in late June to coincide with the common eider egg-laying and early incubation period, 1,148 black brant were observed along the Chukchi Sea coast in Kasegaluk Lagoon and Peard Bay (Dau and Larned, 2005). The current status of the Pacific brant along the Chukchi Sea is unknown.

Kasegaluk Lagoon also is an important stopover location during postbreeding migration. Johnson et al. (1992) observed more than 63,000 black brant in late August in 1989. As much as 45% of the estimated Pacific Flyway population was present at one time in Kasegaluk Lagoon in late August (Johnson, Wiggins, and Wainwright, 1992).

III.B.5.f(6) Greater White-Fronted Goose. The greater white-fronted goose (*Anser albifrons frontalis*) breeds along the coasts of the Bering, Chukchi, and Beaufort seas. In northern portions of Alaska, these geese typically breed within 30 km of the coast (Johnson and Herter, 1989, citing King, 1970). Most greater white-fronted geese reach Alaska via the Central and Pacific Flyways and reach North Slope breeding grounds using overland routes (Johnson and Herter, 1989), but some may reach breeding areas in northwest Alaska (Kotzebue, Wainwright, Barrow) by flying along the coast of the Chukchi Sea (Johnson and Herter, 1989, citing Woodby and Divoky, 1982). In 1989-1991, Johnson, Wiggins, and Wainwright (1992) observed as many as 4,205 white-fronted geese during one aerial survey of Kasegaluk Lagoon. The peaks of migration out of Kasegaluk lagoon appeared to be in the first week of June and the last week of August. Dau and Larned (2005) observed 120 greater white-fronted geese, mostly in the southern half of Kasegaluk Lagoon during a common eider breeding survey. Because greater white-fronted geese breed on tundra, neither the Johnson et al. (1992) or Dau and Larned (2005) survey would be expected to provide an accurate assessment of the numbers of locally breeding white-fronted geese, but the data are useful to illustrate the number of greater white-fronted geese that use Kasegaluk Lagoon at various times of the year. The current status of greater white-fronted geese along the Chukchi Sea coast is **unknown**.

III.B.5.f(7) Lesser Snow Goose. Kasegaluk Lagoon supports one of two consistently used nesting colonies for lesser snow geese (*Chen caerulescens caerulescens*) in the United States. Aerial surveys from 1989-2001 confirmed the presence of molting adults with half-grown goslings there. Point Lay residents also confirmed that snow geese nest on an island in the Kukpowruk River delta (about 60 km south of Point Lay) in the southern portion of Kasegaluk Lagoon. The only other consistently used snow goose-nesting colony in the United States is on the Ikpikpuk River delta near Prudhoe Bay on the North Slope (Ritchie et al., 2006). Ritchie et al. (2006) reported that the number of snow geese nesting on the Ikpikpuk River delta continued to increase substantially from numbers recorded prior to 1999. There are no comparable data for the Kukpowruk River delta colony.

III.B.5.f(8) Tundra Swan. As many as 32 tundra swans (*Cygnus columbianus*) were observed per individual aerial survey in Kasegaluk Lagoon from 1989-1991. Flightless young-of-the-year birds were

observed in 1990 and 1991, indicating that tundra swans breed in Kasegaluk Lagoon (Johnson, Wiggins, and Wainwright, 1992). Tundra swans are particularly sensitive to disturbance.

III.B.5.g. Shorebirds.

Although many shorebirds breed on tundra, they rely on coastal areas such as beaches, barrier islands, lagoons, and mudflats for some portion of their lifecycle. These coastal areas are especially important habitats where shorebirds replenish energy reserves after breeding and prior to southward migration. The most common shorebird species breeding on the Arctic Coastal Plain include dunlin (*Calidris alpina*), semipalmated sandpiper (*Calidris pusilla*), pectoral sandpiper (*Calidris melanotos*), and red phalarope (*Phalaropus fuliacaria*) (Alaska Shorebird Working Group [ASWG], 2004).

While there are certain differences between the Beaufort and Chukchi Sea coastlines, there are likely similarities because many shorebirds leaving the Beaufort Sea move west along the Chukchi Sea coast. For example, the Colville River Delta was shown to host between 41,000 and 300,000 shorebirds between 25 July and 5 September (Andres, 1994; USDO, FWS, 2004a). The range of these numbers is dependent upon how long birds remain in the area before migrating (Andres, 1994; Powell, Taylor, and Lanctot, 2004; Taylor et al., 2006). Results on bird tenure times from the Taylor et al. (2006) project may help clarify the anticipated range of shorebirds using the delta. At the present time, it appears reasonable to assume that large numbers of shorebirds move west along the Chukchi Sea coast, stopping at high-productivity sites to replenish energy reserves and rest. While established for a few sites (Kasegaluk Lagoon and Peard Bay) for a few species, shorebird use of concentration areas along the Chukchi Sea coast has not been well studied.

Some of the most common shorebirds, as well as those that are of special concern due to population declines, are discussed below.

Phalaropes. Both red and red-necked phalaropes (*P. lobatus*) are present in the Chukchi Sea during the open-water periods. Phalaropes are common in pelagic waters as well as within a few meters of shore, where their distribution typically is tied to zooplankton abundance. Due to their reliance on zooplankton, their distribution is patchy; however, because they are tied to a moving prey source they may be encountered throughout the Chukchi Sea in varying concentrations. A minimum of 1 million phalaropes are in the Chukchi Sea during summer (Divoky, 1987). During aerial surveys conducted in Kasegaluk Lagoon from 1989-1991, phalaropes were the most numerous shorebirds present. However, due to the difficulty of identifying small shorebirds from the air, reliable counts were not possible as species identification was not always possible (Johnson, Wiggins, and Wainwright, 1992). Based on ground observations, red phalaropes are considered more common than red-necked phalaropes in Peard bay and Kasegaluk Lagoon. Phalaropes are one of the key species groups of shorebirds that use Kasegaluk Lagoon and Peard Bay, where they stage or stop over in nearshore marine and lacustrine waters (ASWG, 2004). Kinney (1985) reported the Peard bay area was particularly important to migrating juvenile red phalaropes.

Dunlin. Two subspecies breed in Alaska, *Calidris alpina pacifica* and *C. a. arctica*, the latter breeding exclusively in Alaska while *C. a. pacifica* breed primarily in Alaska with small numbers in Canada. The population of *C. a. arctica* is of particular concern because it winters in East Asia, where they are subject to habitat loss due to rapid economic development (ASWG, 2004). Both subspecies are listed as North American species of high concern (USDO, FWS, 2004a,b). Dunlins are one of the key species of shorebirds that use Kasegaluk Lagoon, where they stage or stop over in silt tidal flats and salt-grass meadows (ASWG, 2004).

Shorebird Species of Concern:

Bar-Tailed Godwit. The North American population of bar-tailed godwits (*Limosa lapponica baueri*) breeds in western and northern Alaska. Postbreeding bar-tailed godwits move to staging grounds along the Bering Sea Coast and then apparently fly nonstop 11,000 km to New Zealand. Recent counts conducted at both breeding and nonbreeding sites provide evidence of a serious and rapid population decline (McCaffrey et al., 2006), but the cause of the decline is unknown. The abundance and distribution of bar-tailed godwits in northern Alaska and coastal areas of the Chukchi Sea are not well understood. North American populations of bar-tailed godwits, all of which breed in Alaska, are considered a species of high concern in

the U.S. Shorebird Conservation Plan (USDO, FWS, 2004b). Bar-tailed godwits stage or stop over on silt tidal flats or dwarf shrub meadows (ASWG, 2004).

Buff-Breasted Sandpiper. This species is considered highly imperiled on a global level, because the entire species is restricted to breeding in the United States or Canada (USDO, FWS, 2004b). From limited data available, it appears that buff-breasted sandpipers (*Tryngites subruficollis*) are local and uncommon breeders on the Arctic Coastal Plain and northwestern Canada. They are rare breeders and visitors in northwestern Alaska, but their conservation status is due primarily to threats in the winter-range habitat in South America coupled with the limited breeding distribution and numbers in North America (Brown et al., 2001).

American Golden Plover. The North American population of this species is considered a species of high concern (USDO, FWS, 2004a,b). Much of the cause for concern is due to the population trend and threats during the nonbreeding season in South America. These shorebirds breed on dwarf-shrub meadow and dwarf-shrub mat habitat and stage or stop over on dwarf-shrub meadow and salt-grass meadow (ASWG, 2004).

III.B.5.h. Raptors.

A variety of raptors and corvids may be present in the coastal zone along the Chukchi Sea coast adjacent to the proposed lease sale area. On the North Slope, raptors typically are more common within 20 km of the Brooks Range foothills (Johnson and Herter, 1989) and population densities are lower near the coast, especially during the breeding season. A lack of suitable nesting sites and prey appears to have prevented other raptor species (such as the peregrine falcon, gyrfalcon, rough-legged hawk, and common raven) from occurring along the Chukchi Sea coast in large numbers. Near Kasegaluk Lagoon, snowy owls (*Nycetea scandiaca*) were the most raptor commonly encountered during aerial surveys conducted from 1989-1990. For unknown reasons, snowy owls were not observed during aerial surveys in 1991. As many as 19 snowy owls were encountered on one aerial survey, with most owls located on the tundra in close proximity to Kasegaluk Lagoon (Johnson, Wiggins, and Wainwright, 1992).

III.B.6. Other Marine Mammals.

There are 11 species of marine mammals that occur in the Chukchi Sea that are not listed as endangered or threatened under the Endangered Species Act. They are:

Pinnipeds

Ringed seal (*Phoca hispida*)
 Spotted seal (*Phoca largha*)
 Ribbon seal (*Phoca fasciata*)
 Bearded seal (*Erignathus barbatus*)
 Pacific walrus (*Odobenus rosmarus divergens*)

Cetaceans

Beluga whale (*Delphinapterus leucas*)
 Killer whale (*Orcinus orca*)
 Minke whale (*Balaenoptera acutorostrata*)
 Harbor porpoise (*Phocoena phocoena*)
 Gray whale (*Eschrichtius robusta*)

Marine Fissipeds

Polar bear (*Ursus maritimus*)

There are no State-listed marine mammal species of special concern within the Chukchi Sea Proposed Action area.

III.B.6.a. Pinnipeds.

Five species of pinnipeds are associated with sea ice in Alaskan waters: Pacific walrus and four species of phocid seals (bearded, ribbon, ringed, and spotted). All five species haul out on sea ice to rest, give birth, and molt, and they all perform seasonal migrations in conjunction with the seasonal advance and retreat of ice (Fay, 1974). Ribbon and spotted seals are thought to prefer the loose ice of the "ice front," whereas ringed seals, bearded seals, and walrus are thought to prefer more interior pack ice, when available (Fay, 1974; Burns, Shapiro, and Fay, 1981; Simpkins et al., 2003). Little is known about the biology or population dynamics of ice seals, and they have received little attention compared with other Bering/Chukchi Sea species known to be in decline. Accurate population estimates for ice seals are not available and are not easily attainable due to their wide distribution and problems associated with research in remote, ice-covered waters (Quakenbush and Sheffield, 2006). Although little is known about the population status of ice seals, there is cause for concern. Sea ice is changing in thickness, persistence, and distribution (Sec. III.A.4, Sea Ice), and evidence indicates that oceanographic conditions have been changing in the Bering Sea (Sec. III.A.3, Oceanography), which suggests that changes in the ecosystem may be occurring as well (Quakenbush and Sheffield, 2006).

III.B.6.a(1) Ringed Seal. Ringed seals have a circumpolar distribution from approximately 35° N. latitude to the North Pole, and occur in all seas of the Arctic Ocean (King, 1983). Ringed seals are year-round residents in the Chukchi and Beaufort seas, and are the most common and widespread seal species in the area. They are closely associated with ice. They have the unique ability to maintain breathing holes in thick ice and, therefore, are able to exploit the ice-covered parts of the Arctic during winter when most other marine mammals have migrated south (Rosing-Asvid, 2006). In winter and spring, the highest densities of ringed seals are found on stable, shorefast ice. In summer, ringed seals often occur along the receding ice edges or farther north in the pack ice. Ringed seals seem to prefer icefloes >48 m in diameter and often are found in the interior pack ice, where sea-ice concentrations exceed 90% (Simpkins et al. 2003). Ringed seal densities in the Beaufort Sea are greatest in water with >80% ice cover (Stirling, Kingsley, and Calvert, 1981) and depths between 5 and 35 m (Frost et al., 2004). Densities also are highest on relatively flat ice and near the fast-ice edge, declining both shoreward and seaward of that edge (Frost et al., 2004). Ringed seal densities historically have been substantially lower in the western than the eastern part of the Beaufort Sea (Burns and Kelly, 1982; Kelly, 1988). The lower densities to the west appear to be related to very shallow water depths in much of the area between the shore and barrier islands. Surveys flown from 1996-1999 indicate that the highest density of seals along the central Beaufort Sea coast in Alaska occurred from approximately Kaktovik west to Brownlow Point (Frost et al., 2004). This may be due to the fact that relative productivity, as measure by zooplankton biomass, is approximately four times greater there than the average biomass in other areas of the eastern Beaufort Sea (Frost et al., 2004).

In early summer, the highest densities of ringed seals in the Chukchi Sea are found in nearshore fast and pack ice (Bengston et al., 2005). This also appears to be true in the Beaufort Sea, based on incidental sightings of seals during aerial surveys for bowhead whales (Monnett and Treacy, 2005). During summer, ringed seals are found dispersed throughout open-water areas, although in some regions they move into coastal areas (Smith, 1987; Harwood and Stirling, 1992). In the late summer and early fall, ringed seals often aggregate in open-water areas where primary productivity is thought to be high (Harwood and Stirling, 1992).

No reliable estimate for the size of the Alaska ringed seal stock is available (Angliss and Outlaw, 2005), although past estimates ranged from 1.0 million to 3.6 million (Frost et al., 1988). Ringed seal numbers are considerably higher in the Bering and Chukchi seas, particularly during winter and early spring (71 FR 9783). Recent work by Bengston et al. (2005) reported an estimated abundance of as many as 252,488 ringed seals in the eastern Chukchi Sea. Frost and Lowry (1981) estimated 80,000 ringed seals in the Beaufort Sea during summer and 40,000 during winter, although some authors (Amstrup, 1995) estimated the Beaufort Sea population at four times these numbers. Few, if any, seals inhabit ice-covered waters shallower than 3 m due to water freezing to the bottom and/or poor prey availability caused by the limited amount of ice-free water (71 FR 9785). Frost et al. (2002) reported that population trend analyses in the central Beaufort Sea suggested a substantial decline of 31% in observed ringed seal densities from 1980-1987 to 1996-1999. However, this apparent decline may have been due to a difference in the timing of surveys rather than an actual decline in abundance (Frost et al., 2002). Spatial and temporal comparisons typically rest on the assumption that the proportion of animals visible is constant from survey to survey.

However, Frost et al. (2004) cautioned against comparing survey results because of the marked between-year variation in density estimates common for ringed seal surveys. This likely is due to the timing of the surveys relative to ice conditions and the progress of the seals' annual molt (Frost et al., 2004). In fact, Kelly (2005) found that aerial surveys can underestimate ringed seal densities by factors of >13, because the proportion of seals visible during survey periods can change rapidly from day to day. Therefore, comparisons of ringed seal densities between regions and between years based on aerial surveys should account for the proportion of the population visible during each survey (i.e., appropriate correction factors should be used) (Kelly, 2005). Ringed seals are not listed as "depleted" under the MMPA, and the Alaska stock of ringed seals is not classified as a strategic stock by the NMFS.

Ringed seals give birth from mid-March through April to a single pup, which they nurse for 5-8 weeks (Hammil et al., 1991; Lydersen and Hammill, 1993). Pupping and nursing occur in subnivean lairs constructed on either landfast or drifting pack ice, during which time they are hunted by polar bears (Stirling and Archibald, and DeMaster, 1977; Smith, 1980). Mating occurs shortly after pupping (~ 4 weeks), and the female delays implantation of the embryo until later in the summer (July-August).

Ringed seals feed on a variety of fish and invertebrates. Diet depends on the prey availability, depth of water, and distance from shore. In Alaskan waters, the primary prey of ringed seals is arctic cod, saffron cod, shrimps, amphipods, and euphausiids (Kelly, 1988; Reeves, Stewart, and Leatherwood, 1992).

Reproductive rates for ringed, spotted, and ribbon seals are capable of approaching 95% annually (Smith, 1973; Burns, 1981; Quakenbush and Sheffield, 2006). However, current reproductive rates appear to be lower than the maximum recorded for each species. For example, 69% of female ringed seals sampled in the Bering and Chukchi Seas between 2000 and 2005 were pregnant (Quakenbush and Sheffield, 2006). Similarly, ringed seals in the eastern Beaufort Sea also have exhibited reduced reproductive output and reduced body condition between 2003 and 2005. Local fishers in the eastern Beaufort Sea suggest that the downturn in seal body condition is related to decreased marine productivity in the area, as evidenced by recent reductions in fishing opportunities for arctic cod in the same areas that seals hunt (Harwood, 2005). Reduced arctic cod numbers probably also are a factor in reduced seal reproductive output, as successful ovulation is directly correlated with body condition (Harwood, 2005).

Ringed seals are an important subsistence species for Alaskan Native hunters. The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunter access to seals. The Alaska Department of Fish and Game (ADF&G) maintains a subsistence harvest database and, as of August 2000, the mean estimate of ringed seals taken annually is 9,567 (ADF&G, 2000, as cited in Angliss and Outlaw, 2007).

III.B.6.a(2) Spotted Seal. Spotted seals are distributed along the continental shelf of the Beaufort, Chukchi, Bering, and Okhotsk seas, and south to the northern Yellow Sea and western Sea of Japan (Shaughnessy and Fay, 1977). They are common in the coastal Alaskan waters in ice-free seasons. They migrate south from the Chukchi Sea and into the Bering Sea in October-November (Lowry et al., 1998). Spotted seals overwinter in the Bering Sea and inhabit the southern margin of the ice during spring, moving to coastal habitats after the retreat of the sea ice (Shaughnessy and Fay, 1977; Simpkins et al., 2003). Spotted seals are not known to use the Beaufort Sea in the winter. Spotted seals are closely related to, and often mistaken for, Pacific harbor seals (*Phoca vitulina richardsi*). The two species often are seen together and are partially sympatric in the southern Bering Sea (Quakenbush, 1988).

No reliable estimate for the size of the Alaska spotted seal stock is available (Angliss and Outlaw, 2005). An early estimate of the size of the world population of spotted seals was 370,000-420,000, and the size of the Bering Sea population, including animals in Russian waters, was estimated to be 200,000-250,000 animals (Bigg, 1981). Using telemetry data, the ADF&G corrected 1992 survey results producing a rough estimate of 59,214 animals (Rugh et al., 1993) for western Alaska and the Bering Sea. Spotted seals are not listed as "depleted" under the MMPA. The Alaska stock of spotted seals is not classified by NMFS as a strategic stock.

During spring when pupping, breeding, and molting occur, spotted seals inhabit the southern margin of the sea ice in the Bering Sea (Quakenbush, 1988; Rugh, Sheldon, and Withrow, 1997). Of eight known breeding areas, three occur in the Bering Sea (Angliss and Outlaw, 2005). Pupping occurs on ice in April-

May, and pups are weaned within 3-4 weeks. Adult spotted seals often are seen on the ice in female-pup or male-female pairs, or in male-female-pup triads. Mating occurs around the time the pups are weaned and mating pairs are monogamous for the breeding season. During the summer and fall, spotted seals are found primarily in the Bering and Chukchi seas but some range into the Beaufort Sea (Rugh, Shelden, and Withrow, 1997; Lowry et al., 1998) from July until September. In total, there probably are only a few dozen spotted seals along the coast of the central Beaufort Sea during summer and early fall (Richardson, 2000). At this time of year, spotted seals haul out on land part of the time but also spend extended periods at sea. The seals commonly are seen in bays, lagoons, and estuaries, but they also range far offshore to 72° N. latitude (Shaughnessy and Fay, 1977). Spotted seals are rarely seen on the pack ice during the summer, except when the ice is very near shore.

Adult spotted seal principal foods are schooling fishes, although the total array of foods is quite varied. In the Arctic, their diet is similar to that of ringed seals, including a variety of fishes such as arctic and saffrocod, and also shrimp, and euphausiids (Kato, 1982; Quakenbush, 1988; Reeves, Stewart, and Leatherwood, 1992). Within their geographic range they are known to eat sand lance, sculpins, flatfishes, and cephalopods (mainly octopus). The juvenile diet is primarily crustaceans (shrimp).

Spotted seals are an important subsistence species for Alaskan Native hunters, primarily in the Bering Strait and Yukon-Kuskokwim regions (Lowry, 1984). The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunter access to seals. From 1966-1976, an average of about 2,400 spotted seals was taken annually (Lowry, 1984). The ADF&G maintains a subsistence-harvest database that indicates that at least 5,265 spotted seals are taken annually for subsistence use (ADF&G, 2000, as cited in Angliss and Outlaw, 2007).

III.B.6.a(3) Ribbon Seal. Ribbon seals inhabit the North Pacific Ocean and the adjacent fringes of the Arctic Ocean. In Alaska, they range northward from Bristol Bay in the Bering Sea and into the Chukchi and western Beaufort seas. They are found in the open sea, on pack ice, and rarely on shorefast ice (Kelly, 1988). As the ice recedes in May to mid-July, they move farther north in the Bering Sea, hauling out on the receding ice edge and remnant ice (Burns, Shapiro, and Fay, 1981). Seal distribution throughout the rest of the year is largely unknown; however, recent information suggests that many ribbon seals migrate into the Chukchi Sea for the summer months (Kelly, 1988).

No reliable estimate for the size of the Alaska ribbon seal stock is available (Angliss and Outlaw, 2005). Burns (1981) estimated the Bering Sea population at 90,000-100,000. Ribbon seals are not listed as “depleted” under the MMPA. The Alaska stock of spotted seals is not classified by NMFS as a strategic stock.

Females give birth anytime from early April to about mid-May, with pupping occurring on pack ice. Nursing lasts from 3-4 weeks, during which time a pup’s weight more than doubles. Mating occurs about the time pups are weaned. After weaning, pups spend a great deal of time on the ice, achieving proficiency at diving and feeding. Ribbon seals dive as deep as 200 m in search of food. They eat a variety of different foods, but their main prey is fish; they also are known to consume eelpouts, capelin, pricklebacks, arctic cod, saffron cod, herring, and sand lance. Foods other than fishes include cephalopods (primarily squids), shrimps, mysids, and crabs.

Ribbon seals occasionally are harvested by Alaskan Native hunters, although subsistence-harvest levels are low. The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunter access to seals. The ADF&G maintains a subsistence harvest database, and the mean estimate of ribbon seals taken annually is 193 (Angliss and Outlaw, 2005).

III.B.6.a(4) Bearded Seal. Bearded seals are the largest of the northern phocids, and have a circumpolar distribution ranging from the Arctic Ocean down into the western Pacific (Burns, 1981). In Alaskan waters, bearded seals occur over the continental shelves of the Bering, Chukchi, and Beaufort seas (Burns, 1981). Bearded seals predominantly are benthic feeders (Burns, 1981), feeding on a variety of invertebrates (crabs, shrimp, clams, and snails) and other food organisms, including arctic and saffron cod, flounders, sculpins, and octopuses (Kelly 1988; Reeves, Stewart, and Leatherwood, 1992). Bearded seals also feed on ice-associated organisms when they are present, allowing them to live in areas with water depths considerably deeper than 200 m. In some areas, bearded seals are associated with the ice year-

round; however, they usually move shoreward into open-water areas when pack ice retreats. During the open-water period, bearded seals occur mainly in relatively shallow areas, preferring areas no deeper than 200 m (Harwood et al., 2005; Monnett and Treacy, 2005).

No reliable estimate for the size of the Alaska bearded seal stock currently is available (Angliss and Outlaw, 2005). Bengtson et al. (2005) conducted surveys in the eastern Chukchi Sea but could not estimate abundance from their data. Early estimates of the Bering-Chukchi seas population range from 250,000-300,000 (Burns, 1981). Bearded seals are not listed as “depleted” under the MMPA. The Alaska stock of bearded seals is not classified by NMFS as a strategic stock.

Seasonal movements of bearded seals are directly related to the advance and retreat of sea ice and to water depth (Kelly, 1988). During winter, most bearded seals in Alaskan waters are found in the Bering Sea. From mid-April to June, as the ice recedes, some of the bearded seals that overwintered in the Bering Sea migrate northward through the Bering Strait. During summer, the most favorable bearded seal habitat is found in the central and northern Chukchi Sea, where they are found near the widely fragmented margin of the pack ice; they also are found in nearshore areas of the central and western Beaufort Sea during summer. Suitable habitat is more limited in the Beaufort Sea where the continental shelf is narrower and the pack-ice edge frequently occurs seaward of the shelf and over water too deep for benthic feeding. In the Beaufort Sea, bearded seals rarely use coastal haulouts. Females pup in April-May, bearing a single pup. Breeding occurs within a few weeks after the pup is weaned, and implantation is delayed until July.

Bearded seals are an important subsistence species for Alaskan Native hunters. The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunter access to seals. The ADF&G maintains a database, and the mean estimate of bearded seals taken annually is 6,788 (ADF&G, 2000, as cited in Angliss and Outlaw, 2007).

III.B.6.a(5) Pacific Walrus. No reliable estimate is currently available for the size of the Alaskan stock of Pacific walrus (Angliss and Outlaw, 2005). However, available evidence indicates that the population is likely in decline (Kelly, Quakenbush, and Taras, 1999; Kochnev, 2004).

Pacific walruses range throughout the shallow continental shelf waters of the Bering and Chukchi seas, where their distribution is closely linked with the seasonal distribution of the pack ice. Walruses are migratory, moving south with the advancing ice in autumn and north as the ice recedes in spring (Fay, 1981). Walruses generally are found in waters <200 m deep along the pack ice margin where ice concentrations are <80% (Fay 1982; Fay and Burns, 1988). The juxtaposition of broken ice over relatively shallow continental shelf waters is important to them for resting between feeding bouts, particularly for females with dependent young which may not be capable of deep diving or long term exposure to the frigid water.

Walruses are extremely social and gregarious animals, and spend approximately one-third of their time hauled out onto land or ice, usually in close physical contact with one another. Walruses rely on sea ice as a substrate for resting and giving birth (Angliss and Outlaw, 2005) and generally require ice thicknesses of 50 cm or more to support their weight (Garlich-Miller, 2006, pers. commun.). Pacific walruses are segregated by gender for much of the year as they migrate over vast areas of the Bering and Chukchi Seas (Fay, 1982). The shallow Chukchi Sea and eastern Siberian Sea serve as the main feeding grounds for the bulk of the Pacific walrus population in the summer and autumn (Kochnev, 2004). During the summer months the majority of the subadults, females, and calves move into the Chukchi Sea. In contrast, adult males generally abandon the sea ice in spring for coastal haulouts in Bristol Bay and Gulf of Anadyr (Jay and Hills, 2005). The Chukchi Sea west of Barrow is the northeastern extent of the main summer range of the walrus; few are seen farther east in the Beaufort Sea (e.g., Harwood et al., 2005). Those observed in the Beaufort Sea are typically lone individuals.

Walruses specialize in feeding on benthic macroinvertebrates and prefer to forage in areas <80 m deep (Fay, 1982). In Bristol Bay, 98% of satellite locations of tagged walruses were in water depths \leq 60 m (Jay and Hills, 2005). Walruses most commonly feed on bivalve mollusks (clams), but they also will feed on other benthic invertebrates (e.g., snails, shrimp, crabs, worms). Some walrus have been reported to prey on marine birds and small seals.

Recent trends in seasonal sea-ice break-up have resulted in seasonal sea-ice retreating beyond the continental shelves and over deep Arctic Ocean waters. This trend poses adaptive challenges for the walrus population (Tynan and DeMaster, 1997). Females with calves are not normally observed in deep Arctic basin waters due to the depth of the water and resultant inaccessibility of food there; thus, the recent observations of nine motherless calves stranded on ice floes in deep waters off of northwest Alaska are troubling (Cooper et al., 2006). Considering that walrus calves are dependent on maternal care for 2 years or more before they are able to forage for themselves, this observation of abandoned calves may have implications for the Pacific walrus population (Cooper et al., 2006). These calves may have been abandoned by their mothers due to lack of food, and the authors speculate that much higher numbers than the 9 observed may have been present in their study area.

Walrus are long-lived animals with low rates of reproduction. Females reach sexual maturity at 4-9 years of age, and give birth to one calf every 2 or more years. Although males become fertile at 5-7 years of age, they do not reach full competitive maturity until age 15-16. Some walrus may live to age 35-40, and they remain fertile until relatively late in life. In winter, Pacific walrus inhabit the pack ice of the Bering Sea. Breeding occurs between January and March, and implantation is delayed until June-July. Gestation lasts 11 months, and calving occurs on the sea ice in April-May approximately 15 months after mating. Calves are not weaned for 2 years or more after birth (Fay, 1982). By May as the pack ice loosens, adult females and dependent young move northward into the Chukchi Sea. In summer, walrus tend to concentrate in areas of unconsolidated pack ice within 100 km of the leading edge of the pack ice in the Chukchi Sea. By July, large groups of up to several thousand walrus can be found along the edge of the pack ice between Icy Cape and Point Barrow. When suitable pack ice is not available, walrus will haul out to rest on land, preferring sites sheltered from wind and surf. Traditional haulout sites in the eastern Chukchi Sea include Cape Thompson, Cape Lisburne, and Icy Cape. Similarly, within the last 5 years, walrus have begun hauling out in herds numbering in the thousands along the north coast of Chukotka in the fall (Johnson, 2006, pers. commun.). By August, depending on the retreat of the pack ice, walrus are found farther offshore, with principal concentrations to the northwest of Barrow. By September, the edge of the pack ice generally retreats to about 71° N. latitude, although it may retreat as far as 76° N. latitude in some years. In October, as the pack ice advances, large herds begin moving back down to the Bering Sea.

In fall, migrating walrus often have to cross large distances of open water between the leading ice edge and haulout sites, where they can rest on shore (Kochnev, 2004). Up to 125,000 walrus have been estimated to use coastal haulouts on Wrangel Island in the Russian Arctic (Kochnev, 2004), and from 10-13 walrus-haulout sites occur annually in summer and autumn on the Arctic coast of Chukotka. The large number of lean walrus at coastal haulouts in the fall indicates that they feed little while swimming across open water. During autumns of minimal ice, walrus are relegated to these sites, which limits their feeding opportunities and likely results in great energy loss prior to winter. This is because walrus tend to use ice haulouts when they are available over shallow waters, because the constantly moving ice provides easy access to undepleted food resources. When ice retreats far to the north in autumn, walrus are forced to use crowded terrestrial haulouts. Under these conditions, competition for food resources within their foraging range of the haulout can be fierce. Prey abundance within foraging range can be depleted, resulting in poor body condition. The high density of animals in many haulouts creates additional stress on these tired and hungry animals, which are prone to death by stampede. The level of mortality at haulouts on Wrangel Island and the Arctic coast of Chukotka is estimated to be 3-6 times higher than at summer haulouts in the Bering Sea (Kochnev, 2004). Because the majority of haulouts on the Chukotka coast are near native villages, they also are susceptible to human harvest. Polar bears, brown bears, and wolverines also prey on walrus at haulouts. For these reasons, all the haulouts of the Arctic coast of Chukotka are characterized by a high disturbance level, which results in stressed animals and mortalities due to predation and stampedes. During ice-free years, killer whales appear more frequently and also take a toll on walrus. In addition, the absence of ice increases the severity of autumn storms, which can induce further stress, and result in mortalities and the separation of mother/calf pairs (USDOI, FWS, 2005b). This may be one of the reasons for observed low pup survival in recent years (Kelly, Quakenbush, and Taras, 1999; Kochnev, 2004). Furthermore, weakened animals are more susceptible to diseases; in recent years, for example, ulcers observed on harvested and captured walrus have been linked to bacterial infections of unknown etiology (Kochnev, 2004). Repetition of such conditions over the last decade likely have resulted in increased mortalities among juveniles and weakened adult walrus and may be the major cause of apparent population declines (Kochnev, 2004). On the American side of the Chukchi, walrus-haulout sites

are relatively rare (Kochnev, In prep.), although in recent years, Cape Lisburne has seen regular walrus use in the late summer (USDOI, FWS, pers. comm.).

In 2002, walrus haulouts occurred at an unusual place on the north coast of Chukotka, between Cape Schmidt and the Native village of Vankarem. Walrus haulouts had never been reported there before, yet this time they formed a large coastal rookery (Ovsyanikov, 2003). According to Charles Johnson, Executive Director of the Alaska Nanuq Commission, walrus herds have begun hauling out in great numbers along the north coast of Chukotka within the last 5 years outside the Native village of Vankarem (Johnson, 2006, pers. commun.).

Over the past decade, the numbers of walrus haulouts in Bristol Bay, along the coast of Kamchatka, and in the Bering Strait and Gulf of Anadyr have steadily declined, which may indicate a declining walrus population (Smirnov et al., 2004). According to Smirnov et al. (2004) and others, it is increasingly clear that efforts must be made to improve the protection and monitoring of the Pacific walrus' most vulnerable habitats, their coastal haulouts.

No reliable estimate for the size of the Alaska Pacific walrus stock is available (Angliss and Outlaw, 2005). The FWS, in collaboration with USGS and Russian scientists from GiproRybFlot and ChukotTINRO, conducted a rangewide survey of the Pacific walrus population in March and April 2006. The primary goal of the survey was to estimate the size of the Pacific walrus population across its spring range, which is the ice-covered continental shelf of the Bering Sea. The U.S. and Russian scientific crews coordinated aerial-survey efforts on their respective sides of the international border. Walrus haulouts were counted using a combination of aerial thermal imagery and photography. The final population estimate will be developed cooperatively by U.S. and Russian scientists, and results are expected in late 2007.

Estimates of the Pacific walrus population suggest a minimum of 200,000 animals were necessary to withstand the levels of commercial harvest, which occurred in the 18th and 19th centuries (Fay, 1982). The population size has never been known with certainty; however, the most recent survey estimate was approximately 201,039 animals (Gilbert et al., 1992). Pacific walrus haulouts are not listed as "depleted" under the MMPA. The Alaska stock of Pacific walrus is not classified by NMFS as a strategic stock.

The Pacific walrus is an important subsistence species for Alaskan Native hunters. The number of walrus haulouts taken annually has varied over the years, with recent harvest levels much lower than historic highs. Based on harvest data from Alaska and Chukotka in the years 2001-2005, mean harvest mortality levels are estimated at 5,458 animals per year (USDOI, FWS, 2006b).

Given the importance of the offshore habitats within the Chukchi Sea Planning Area to the Pacific walrus population, the documented sensitivity of walrus haulouts to anthropogenic disturbances, and the significance of walrus hunting to the economy and culture of indigenous communities in Alaska and Chukotka, the Pacific walrus is a species of special concern (USDOI, FWS, pers. commun.).

III.B.6.b. Cetaceans.

III.B.6.b(1) Beluga Whale. Beluga whales are found throughout the arctic and subarctic waters of the Northern Hemisphere. They inhabit seasonally ice-covered waters and are closely associated with open leads and polynyas in ice-covered regions (Hazard, 1988). In summer months, they migrate to warmer coastal estuaries, bays, and rivers (Finley, 1982). In Alaska there are five recognized stocks: (1) Eastern Chukchi Sea; (2) Beaufort Sea; (3) Cook Inlet; (4) Bristol Bay; and (5) Eastern Bering Sea (O'Corry-Crowe et al., 1997). Within the Proposed Action area, only the Beaufort Sea stock and eastern Chukchi Sea stocks are present. During June, July, and part of August it is likely that the ranges of the two stocks do not overlap much (Suydam, Lowry, and Frost, 2005). Based on recent telemetry studies on eastern Chukchi belugas, it is likely that members from both stocks occur in similar places and at similar times during the fall migration although the significance of this is unknown (Suydam, Lowry, and Frost, 2005). The NMFS has set the minimum population estimate for the Beaufort Sea beluga whale stock at 32,453 and the eastern Chukchi Sea stock at 3,710 (Angliss and Outlaw, 2005). Of the five beluga whale stocks, only the Cook Inlet stock is listed as "depleted" under the MMPA (Angliss and Outlaw, 2005). Neither the Beaufort Sea nor the eastern Chukchi Sea stocks are listed as "depleted" or classified as a strategic stock under the MMPA.

Pod structure in beluga groups appears to be along matrilineal lines, with males forming separate aggregations. Small groups often are observed traveling or resting together. Females calve in the May-July, when herds are in their summer areas. Calves typically are weaned at 2 years of age. Mating occurs in the early spring (March-April).

Beluga whales of both stocks winter in the Bering Sea and summer in the Beaufort and Chukchi Seas, migrating around western and northern Alaska along the spring lead system in April and May (Richard, Martin, and Orr, 2001; Angliss and Outlaw, 2005). The majority of belugas in the Beaufort stock migrate into the Beaufort Sea in April or May, although some whales may pass Point Barrow as early as late March and as late as July (Braham et al., 1984; Ljungblad, Moore, and Van Schoik, 1984; Richardson et al., 1995a). Most belugas move into shallow coastal or estuarine waters during at least a portion of the summer (Caron and Smith, 1990; Frost and Lowry, 1990). These areas of summer concentration are consistent from year to year, and the waters are usually brackish and relatively warm (Suydam, Lowry, and Frost, 2005). Eastern Chukchi belugas move into coastal areas along Kotzebue Sound and Kasegaluk Lagoon in late June and remain there until mid to late July (Suydam et al., 2001; Suydam, Lowry, and Frost, 2005). Subsistence hunting occurs on this stock during their time in these waters. The absence of significant stomach contents of belugas killed in this hunt suggests that feeding is not the major reason for their presence near Kasegaluk Lagoon during this time (Suydam, Lowry, and Frost, 2005). Some of the largest gravel beds in the Chukchi Sea occur in Kasegaluk Lagoon and research suggests these areas are likely used for molting (Frost, Lowry, and Carroll, 1993). The low saline content and warmer water exiting the lagoons may facilitate the molting process (Suydam, Lowry, and Frost, 2005).

After leaving coastal areas, it is believed the animals move northeastward and spend the remainder of the summer in the northern Chukchi and western Beaufort seas. During the late summer and autumn, most belugas migrate far offshore near the pack-ice front (Frost et al., 1988; Hazard, 1988; Clarke, Moore, and Johnson, 1993; Miller, Elliott, and Richardson, 1998). During the remainder of the summer, beluga whales also can be found in large aggregations further offshore and associated with deeper slope water. Recent research suggests that belugas are not necessarily limited by heavy ice cover (>90%) during this time and are able to travel great distances in short time periods (Suydam, Lowry, and Frost, 2005). Whales may remain in pods for weeks or months or may move as much as 700 km apart and converge again later (Suydam et al., 2001). From satellite-tagged animals, it appears that all belugas that move north of 75° N. latitude are males, whereas females remain at or near the shelf break throughout summer and early fall (Suydam, Lowry, and Frost, 2005). Belugas of all ages and both sexes prefer water deeper than 200 m along and beyond the continental shelf break. Moore (2000) and Moore et al. (2000) suggest that beluga whales select deeper slope water independent of ice cover.

The main fall-migration corridor of beluga whales is ~100+ km north of the coast. During that time, belugas can be found in large groups exceeding 500 animals. In the eastern Beaufort Sea, the westward fall migration begins in late August to mid-September (Treacy, 1994; Richard, Martin, and Orr, 1997, 2001; Richard et al., 1998). Movements of tagged belugas indicate that the western Chukchi Sea is an autumn migratory destination, with many whales moving into Russian waters near Wrangel Island between mid-September and early October. They remain near Wrangel Island for weeks before moving south into the Bering Sea (Richard, Martin, and Orr, 2001). These whales often number into the hundreds and occasionally remain in certain areas near Wrangel Island for periods of up to a month, possibly to feed (Richard et al., 1998, Richard, Martin, and Orr, 2001).

Winter food habits of belugas are largely unknown; however, during summer they feed on a variety of schooling and anadromous fishes that are sequentially abundant in coastal zones. Principal species eaten include arctic and saffron cods, herring, capelin, smelt, salmon, flatfishes, char, whitefish, and sculpins (Frost and Lowry, 1990; Richard, Martin, and Orr, 2001). Octopus, squid, shrimps, crabs, and clams are eaten occasionally. Most feeding is done over the continental shelf and in nearshore estuaries and river mouths. In the shallow waters of Alaska, most feeding dives are probably to depths of 20-100 ft (6-30 m) and last 2-5 minutes. Belugas generally are associated with ice and relatively deep water throughout the summer and autumn, which may reflect their preference for feeding on ice-associated arctic cod (Moore et al., 2000). Late-summer distribution and fall-migration patterns are poorly known, wintering areas are effectively unknown, and areas that are particularly important for feeding have not been identified (Suydam, Lowry, and Frost, 2005).

Beluga whales from both stocks are an important subsistence resource for Alaskan Native hunters. For the eastern Chukchi Sea stock, annual subsistence take averaged 65 animals from 1999-2003. Annual subsistence take for the Beaufort Sea stock averaged 53 animals for the same period (Angliss and Outlaw, 2005). Beluga whales from the eastern Chukchi Sea stock are an important subsistence resource for residents of the village of Point Lay, adjacent to Kasegaluk Lagoon, and other villages in northwest Alaska (Suydam et al., 2001).

III.B.6.b(2) Killer Whale. Killer whales are found in all oceans and seas of the world and are common in temperate waters; however, they also frequent tropical and polar waters. The greatest abundance is thought to occur within 800 km of major continents (Mitchell, 1975). Along the west coast of North America, killer whales occur along the entire Alaskan coast (Braham and Dahlheim, 1982). This includes the Chukchi Sea, into the Bering Sea, along the Aleutian Islands, the Gulf of Alaska, and into southeast Alaska.

Killer whales in Alaska are composed of two stocks: the eastern north Pacific resident stock and the eastern north Pacific transient stock. Population abundance for the transient stock includes animals from British Columbia (trans-boundary) and is estimated at a minimum of 346 individuals. The resident stock also is a trans-boundary stock, including animals from British Columbia. Population estimates for this stock are estimated at a minimum of 723 individuals. Only the AT1 pod of killer whales, occurring primarily in Prince William Sound and the Kenai Fjords region, is listed as “depleted” under the MMPA and designated by NMFS as a strategic stock (Angliss and Outlaw, 2005). Killer whales occurring in the Beaufort and Chukchi are not listed as “depleted” under the MMPA or classified by NMFS as a strategic stock.

Killer whales travel through the Bering Strait in the spring as the pack ice retreats and can be found in the Beaufort and Chukchi seas until fall, when the ice advances. Killer whales travel in close-knit matrilineal groups and appear to follow the distribution of their prey. Calving occurs in the late fall to spring. Killer whales are opportunistic feeders and will prey on a variety of prey items including marine mammals, fish, and squid.

Killer whales are not harvested as a subsistence species by Alaskan Native hunters.

III.B.6.b(3) Minke Whale. In the North Pacific, minke whales range into the Bering and Chukchi seas south to the equator (Leatherwood et al., 1982). Minke whales are not considered to range into the Beaufort Sea. There are two stocks that occur within U.S. waters: (1) Alaska stock; and (2) California/Washington/Oregon stock (Angliss and Outlaw, 2005). In Alaska, minke whales are believed to be migratory in contrast to whales from the Washington/Oregon/California stock that establish inland coastal home ranges (Dorsey et al., 1990).

There are no reliable estimates for the Alaska stock of minke whales. A provisional estimate was made for the Bering Sea of 810 individuals; however, this is not used for the Alaska stock because the entire stock’s range was not surveyed. Minke whales are not listed as “depleted” under the MMPA or classified by NMFS as a strategic stock.

Minke whales are known to penetrate loose ice in summer. Aerial surveys suggest that minke whales are associated with the 100-m contour in upper slope waters (Moore et al., 2000). They are either solitary or found in small groups, but they can occur in large aggregations associated with concentrations of prey in the higher latitudes. Calving occurs during the winter months at the lower latitudes. Minke whales feed on both fish (e.g., herring, sand lance) as well as on invertebrates (e.g., euphysiids, copepods).

Minke whales are rarely used as a subsistence species by Alaskan Natives, but some takes have occurred. Annual subsistence takes average zero in recent history (Angliss and Outlaw, 2005).

III.B.6.b(4) Harbor Porpoise. The harbor porpoise inhabits shallow, coastal areas in temperate, subarctic, and arctic waters of the Northern Hemisphere (Read, 1999). In the North Pacific, harbor porpoises range from Point Barrow, Alaska to Point Conception, California (Gaskin, 1984). In Alaska, three separate stocks have been recommended, although there is insufficient biological data to support the designation at this time. The southeast Alaska stock, the Bering Sea stock, and the Gulf of Alaska stock

have been identified based on arbitrarily set geographic boundaries (Angliss and Outlaw, 2005). The Bering Sea stock is the only stock expected to be present in the action area.

Minimum population estimate for the Bering Sea stock of harbor porpoises is 39,328 (Angliss and Outlaw, 2005). The Bering Sea stock of harbor porpoise is not listed as “depleted” under the MMPA or classified by NMFS as a strategic stock.

Harbor porpoises occur mainly in shelf areas (Read, 1999), diving to depths of at least 220 m and staying submerged for more than 5 minutes (Harwood and Wilson, 2001). Harbor porpoises typically occur in small groups of only a few individuals (Read, 1999); however, they can be observed in larger aggregations during feeding or migration. Calving occurs during spring-early summer, and calves are weaned within a year. Harbor porpoises feed on a variety of small, schooling fish and cephalopods (Read, 1999).

Harbor porpoises are not taken by Alaskan Native hunters for subsistence.

III.B.6.b(5) Gray Whale. Gray whales formerly inhabited both the North Atlantic and North Pacific oceans; however, they are believed to have become extinct in the Atlantic by the early 1700’s. There are two stocks recognized in the North Pacific: the eastern north Pacific stock, which lives along the west coast of North America; and the western north Pacific stock, which lives along the coast of eastern Asia (Angliss and Lodge, 2005).

Gray whales were commercially hunted during the 19th and 20th centuries, which reduced the eastern north Pacific population to perhaps as few as 1,000-2,000 whales (Moore et al., 2001). The latest abundance estimate (2001/02) for the eastern north Pacific stock is 18,178 individuals (Rugh et al., 2005). NMFS has provided a minimum population estimate of 17,752 (Angliss and Lodge, 2005). Abundance estimates were 29,758 whales in 1997/98 and 19,448 in 2000/01 (Rugh et al., 2005). Wade and Perryman (2002) calculated gray whale carrying capacity (*K*) from abundance data with a 90% credibility interval of 19,830 to 28,740, suggesting that the population is essentially at *K*. Declining abundance estimates may be the first clear indication that the gray whale population is responding to environmental limitations. It is anticipated that abundance estimates will rise and fall in the future as the population finds a balance with the carrying-capacity of the environment (Rugh et al., 2005). Federal protection under the ESA for gray whales was removed in 1994, and further evaluation determined that the stock was neither in danger of extinction nor likely to become endangered in the foreseeable future (Rugh et al., 1999). The eastern North Pacific stock is not designated as depleted under the MMPA nor considered a strategic stock by NMFS.

During the summer months, eastern north Pacific gray whales and their calves feed in the northern Bering and Chukchi seas (Tomilin, 1957; Rice and Wolman, 1971; Braham, 1984; Nerini, 1984), particularly north of St. Lawrence Island and in the Chirikov Basin (Moore et al., 2000). Gray whales prefer areas of little or no ice cover (<5%) (Moore and DeMaster, 1997). They are a coastal species, spending most of their time in waters <60 m deep. In mid-October, the whales begin their migration to the west coast of Baja California and the east coast of the Gulf of California to breed and calve (Swartz and Jones, 1981; Jones and Swartz, 1984). The northbound migration starts in mid-February and continues through May (Rice, 1984). Calves are weaned during the feeding season at approximately 6 to 8 months of age (Bradford et al., 2006). The long migration to northern waters is undertaken in order to feed in a location where food is sufficiently abundant that nearly an entire year’s energy requirements can be harvested in about 6 months (Highsmith and Coyle, 1992).

Killer whale predation on gray whales has been well documented. Weller et al. (2002a) recorded that at least 33% of identified western gray whales had visible killer whale tooth rakes on their bodies, indicating that they are subject to killer whale predation in some portion of their range.

Gray whales are bottom feeders, sucking sediment from the seafloor. Their primary prey is amphipods, although other food items are ingested. As the population expands, it is believed that gray whales also are expanding their feeding areas in Arctic Alaska. Although gray whales probably feed opportunistically throughout their range, they return annually to primary feeding areas in the northern Bering Sea and Chukchi Sea (Moore and Clarke, 2002). The northeastern-most recurring known gray whale feeding area is in the Chukchi Sea southwest of Barrow (Clarke, Moore, and Ljungblad, 1989). During aerial surveys in the Alaskan Chukchi and Beaufort Seas in 1982-1991, gray whales were associated with virtually the same

habitat throughout the summer and the autumn (38 m depth and <7% ice cover) (Moore and DeMaster, 1997). Gray whale feeding habits in the northern Chukchi Sea appear limited to shoal and coastal waters and their selection of shoal and coastal habitat is greatest in the summer (Moore et al., 2000). It is likely that shallow coastal and offshore-shoal areas provide habitat rich in gray whale prey, and their association and congregation in larger numbers with offshore shoals in the northern Chukchi Sea may indicate that these are important feeding areas for the expanding population (Moore and DeMaster, 1997; Moore et al., 2000). Because shallow shoals and coastal areas provide habitat rich in gray whale prey, there is little reason for whales to abandon it prior to beginning their southbound migration.

Only a small number of gray whales enter the Beaufort Sea east of Point Barrow, although in recent years, ice conditions around Barrow have become lighter and gray whales may have become more common there. In fact, Moore et al. (2006) reported that Native hunters have noticed increasing numbers of gray whales near Barrow in late summer and autumn, which may indicate a northward shift in the distribution of this species. Gray whale calls also were recorded each month from October 2003 through May 2004 northeast of Barrow, indicating that some whales overwintered in the Beaufort Sea and did not migrate to California as expected (Moore et al., 2006). This extended occurrence of gray whales in the Beaufort Sea complements observations of feeding whales moving north from the Bering Sea to the Chukchi Sea in summer (Moore, Grebmeier, and Davies, 2003), and may be indicative of marine ecosystem changes occurring in the North Pacific (Grebmeier et al., 2006). For example, Moore, Grebmeier, and Davies (2003) suggested that gray whale use of the Chirikov Basin has decreased, likely as a result of the combined effects of changing currents and a dramatic downturn in amphipod productivity, perhaps due to overgrazing by whales. Whale sighting rates were highest where ampeliscid amphipods dominated the benthos. Arctic amphipod communities may be quite sensitive to increased predation by the expanding gray whale population, due to their longer generation times and lower growth rates (Highsmith and Coyle, 1992). Fine scale indices of whale abundance were associated with the highest biomass of one particular amphipod-dominated faunal group, suggesting strong prey selection, perhaps indicative of these being a key prey species (Moore, Grebmeier, and Davies, 2003). However, gray whales' unique capacity to forage by suctioning dense mats of amphipods from the sea floor coupled with the temporal and spatial breadth of prey species and feeding opportunities confounds a comprehensive assessment of prey availability (Moore et al., 2001).

Gray whales are taken by both Alaskan and Russian subsistence hunters; however, most of the harvest is done by the Russians. The only reported takes in Alaska in the last decade occurred in 1995, when Alaskan Natives harvested two animals (IWC, 1997). In 1997, the IWC implemented an annual cap of 140 gray whales to be taken by Russia and the U.S. (Makah Indian Tribe in Washington State). Annual subsistence take averaged 122 whales from 1999-2003 (Angliss and Lodge, 2005). The Makah Indian Tribe in Washington State is authorized to take four gray whales from this stock each year, but the last reported harvest was one animal in 1999 (IWC, 2001).

III.B.6.c. Marine Fissipeds – Polar Bear.

According to the FWS, the status of polar bears worldwide is declining as a result of climate changes, loss of ice habitat, and unregulated hunting pressures (USDOJ, FWS, 2005b).

On February 16, 2005, the Centers for Biological Diversity (CBD) petitioned the FWS to list the polar bear as a threatened species under the Endangered Species Act due to global warming and the melting of their sea ice habitat (CBD, 2005). In June 2005, the IUCN/SSG (World Conservation Union/Species Survival Commission) Polar Bear Specialist Group (PBSG) concluded that the IUCN Red List classification of the polar bear should be upgraded from Least Concern to Vulnerable based on the likelihood of an overall decline in the size of the total world polar bear population by more than 30% within the next 35-50 years. The principle reason for this projected decline is "climatic warming and its consequent negative effects on the sea ice habitat of polar bears" (IUCN/SSG, Polar Bear Specialist Group, 2005). On February 7, 2006, the 90-day finding by the FWS determined that the CBD petition contained sufficient information indicating that listing polar bears as threatened may be warranted. The FWS conducted a 12-month status review of the species to determine whether listing was warranted and concluded the status review with a positive finding. On January 7, 2007, the FWS proposed to list the polar bear as a threatened species under the Endangered Species Act.

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

Polar bears are a classic *K*-selected species, meaning they have delayed maturation, small litter sizes, and high adult survival rates (Bunnell and Tait, 1981). Because polar bears exist in relatively small populations and have low reproductive rates, populations may be detrimentally impacted by even small reductions in their numbers (Amstrup, 2000). Their low reproductive rate requires that there must be a high rate of survival to maintain population levels (Amstrup, 2003). Mating occurs from March to May, followed by a delayed implantation in the autumn (Ramsay and Stirling, 1988). In any given year, 30-60% of the available adult females do not breed or are not impregnated (Taylor et al., 1987). Females give birth the following December or January to one to three cubs, which remain with their mother until they are at least 2 years of age (Harington, 1968; Jefferson, Leatherwood, and Webber, 1993). Females will not rebreed until they separate from their cubs. In the Beaufort Sea, female polar bears usually do not breed for the first time until they are 5 years of age (Lentfer and Hensel, 1980), which means that they give birth for the first time at age 6. The maximum reproductive age for polar bears is unknown, but is likely well into their 20's (Amstrup, 2003). The average reproductive interval for a polar bear is 3-4 years, and a female may produce 8-10 cubs in her lifetime, of which only 50-60 percent will survive (Amstrup, 2003). A complete reproductive cycle is energetically expensive for female polar bears. When nutritionally stressed, female polar bears can forgo reproduction rather than risk their own survival (Amstrup, 2003). This is possible because implantation of the fertilized egg is delayed till autumn; hence, a malnourished female unable to sustain a pregnancy can terminate the process by aborting or resorbing the fetus (Amstrup, 2003).

Recent information on changes in polar bear reproductive success, physical stature, and survival indicate that the status of polar bears in the Southern Beaufort Sea region is changing (Regehr et al., 2006). The most recent USGS population estimates for the SBS polar bear population is ~1,526 animals, down from previous estimates of ~1,800. An unprecedented number of adult female polar bears have been found starved to death in recent years, and adult male body weights have declined. Survival rates of cubs of the year (COY) are now significantly lower than they were in previous studies, and there also has been a declining trend in COY size. Although many cubs are being born into the SBS region, more females are apparently losing their cubs shortly after den emergence, and these cubs are not being recruited into the population (Regehr, Amstrup, and Stirling, 2006).

In northern Alaska, pregnant females enter maternity dens by late November and emerge as late as early April. Maternal dens typically are located in snow drifts in coastal areas, stable parts of the offshore pack ice, or on landfast ice (Amstrup and Garner, 1994). Studies have shown that more bears are now denning nearshore rather than in far offshore regions. In fact, recent data indicate that ~64% of all bear dens in Alaska from 1997-2004 occurred on land, compared to only ~36% of dens from 1985-1994. This trend is thought to be related to climate change and changing sea-ice conditions (Fischbach, 2007). The highest density of land dens in Alaska occur along the coastal barrier islands of the eastern Beaufort Sea and within the Arctic National Wildlife Refuge (Amstrup and Garner, 1994; USGS, pers. comm.). In the Chukchi Sea, polar bear denning also occurs at Cape Lisburne; Cape Beaufort; the barrier islands between Point Lay and Peard Bay; the Kukpowruk, Kuk, and Sinaruruk rivers; Nokotlek Point; Point Belcher; Skull Cliff; and Wainwright Inlet. Although most polar bear denning in the Chukchi Sea occurs in Russia, traditional ecological knowledge indicates that denning may be more frequent along Alaska's Chukchi Sea coast than scientific studies previously have been able to quantify (USDOI, FWS, 1995; Kalxdorff, 1997). In addition, the distribution of denning areas may be changing as a result of climate change. Because of the

importance of denning habitat to the population, identifying all known denning habitat is crucial when evaluating potential industrial activities.

Newborn polar bears are among the most undeveloped of placental mammals; therefore, undisturbed maternal dens are critical in protecting them from the rigors of the arctic winter for the first 2 months of life (Amstrup, 2000). Denning females are particularly sensitive to disturbance, and any cubs driven from their dens at this time likely will die. Significant changes in cub survival and physical stature ultimately must have population-level effects (Regehr et al., 2006). For example, in other regions, declines in cub survival and physical stature were documented before statistically significant declines in population size were confirmed. Protecting these core maternity denning areas is of critical importance to the long-term conservation of polar bears.

The coast, barrier islands, and shorefast ice edge provide an important corridor for polar bears traveling and feeding during fall, winter, and spring months. Late winter and spring leads that form off shore from the Chukchi Sea coast also provide important feeding habitat for polar bears. For example, polar bears usually forage in areas where there are high concentrations of ringed seals, as these are their primary prey (Stirling and McEwan, 1975; Larsen, 1985), although bearded seals, walruses, and beluga whales also are taken opportunistically (Amstrup and DeMaster, 1988). Polar bears are almost completely carnivorous, although they will feed opportunistically on a variety of foods including carrion, bird eggs, and vegetation (Smith, 1985; Smith and Hill, 1996; Derocher, Wiig, and Bangjord, 2000). Polar bears prefer shallow-water areas, perhaps reflecting similar preferences by their primary prey—ringed seals—as well as the higher productivity in these areas (Durner et al., 2004). For example, in spring, polar bears in the Beaufort Sea overwhelmingly prefer regions with ice concentrations >90% and composed of icefloes 2-10 km in diameter (Durner et al., 2004). In summer, bears in the Beaufort Sea select habitats with a high proportion of old ice, which takes them far from the coast as the ice melts. In fact, 75% of bear locations in the summer occur on sea ice in waters >350 m deep, which places them outside the areas of greatest prey abundance. This is because ringed seals tend to aggregate in open-water areas in the late summer and early fall, where primary productivity is thought to be high (Harwood and Stirling, 1992), thus placing them well out of reach of polar bears summering on the pack ice. The distribution of seals and the habitat-selection pattern by bears in the Beaufort Sea suggests that most polar bears do not feed extensively during summer (Durner et al., 2004), which is supported by reports of the seasonal activity levels of polar bears. Amstrup, Durner, and McDonald (2000) showed that polar bears in the Beaufort Sea have their lowest level of movements in September, which correlates with the period when the sea ice has carried polar bears beyond the preferred habitat of seals. Conversely, 75% of bear observations in winter occurred in waters <130 m deep. During winter, polar bears prefer the lead system at the shear zone between the shorefast ice and the active offshore ice. This narrow zone of moving ice parallels the coastline and creates openings that are used by seals. Thus, polar bears in winter use a relatively small area of the Beaufort Sea where prey are most abundant and accessible (Durner et al., 2004). Consequently, changes in the extent and type of this ice cover are expected to affect the distributions and foraging success of polar bears (Tynan and DeMaster, 1997).

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

The polar bear's preferred habitat is the annual ice over the continental shelf and inter-island archipelagos that encircle the polar basin (Derocher, Lunn, and Stirling, 2004). Recent research has indicated that the total sea ice extent has declined over the last few decades, particularly in both near shore areas and in the amount of multiyear ice in the polar basin (Parkinson and Cavalieri, 2002; Comiso, 2002a,b). Polar bears and ringed seals depend on sea ice for their life functions, and reductions in the extent and persistence of ice in the Beaufort and Chukchi seas almost certainly would have negative effects on their populations (USDOI, FWS, 1995b). Climate change already has affected polar bears in Western Hudson Bay (WHB) in Canada, where they hunt ringed seals on the sea ice from November to July and spend the open-water season fasting onshore. In a long term study, Stirling, Lunn, and Iacozza (1999) correlated decreased body condition and reproductive performance in bears with a trend toward earlier breakup of sea ice in recent years. The earlier breakup shortens the bears' feeding season and increases the length of their fasting

season. Because ringed seals often give birth to and care for their pups on stable shorefast ice, changes in the extent and stability of shorefast ice and/or the timing of breakup could reduce their productivity. This is important, because the most critical factor affecting the reproductive success, condition, and survival of polar bears is the availability of ringed seal pups from approximately mid-April till breakup (Stirling and Lunn, 1997). As a result of this close predator-prey relationship between polar bears and ringed seals, decreases in ringed seal abundance can be expected to cause declines in polar bear populations (Stirling and Oritsland, 1995). In fact, a new analysis of the Western Hudson Bay polar bear subpopulation confirms that it has declined by almost 20% in the last 30 years (IUCN/SSG, Polar Bear Specialist Group, 2005), and that this decline is linked to significant reductions in the apparent survival of ringed seal pups coincident with earlier sea-ice breakup.

Climate change also may help explain why coastal communities in Western Hudson Bay have experienced increased bear-human conflicts prior to freezeup each fall. With earlier sea ice breakup, polar bears are forced ashore earlier, in poorer nutritional condition, and remain without access to seals for a longer time. As they exhaust their fat reserves towards the end of the ice-free period, they are more likely to encroach on human settlements in search of alternative food sources and come into conflict with humans. Thus, the increase in polar bear-human interactions in Western Hudson Bay probably reflects an increase in nutritionally stressed bears searching for food (Amstrup et al., 2006). Similar effects may be expected to occur in Alaska if climate change continues.

The reduction in summer ice cover also might affect polar bears in other ways. For example, the Sale 195 EA explained that reductions in sea-ice coverage would adversely affect the availability of pinnipeds as prey for polar bears (USDOJ, MMS, 2004:Appendix I, Sec. I.2.e(1)). Also, summer sea-ice reduction would affect the severity of storm events along the coast of Alaska, with consequent effects on polar bears. When the ice cover is reduced, particularly during late summer, the available open-water surface increases, and waves are able to grow in height. For example, rough weather prevented scouting about one-third of the time that whaling crews were on Cross Island during 2001 (Galginaitis and Funk, 2004:24) and about half of the time during 2003 (Galginaitis and Funk, 2005:18). The unusually rough water that restricted the scouting for whales might have been related to changes in the summer sea-ice cover during recent years. Long-term data sets indicate substantial reductions in both the extent and thickness of the arctic sea-ice cover during the past 20-40 years, with record minimum extent in 2002 and again in 2005, and extreme minima in 2003 and 2004 (Stroeve et al., 2005; NASA, 2005). Wave heights in the Beaufort Sea typically range from 1.5 m during summer to 2.5 m during fall, though maximum wave heights of 7-7.5 m are expected (Brower et al., 1988). In fact, a late-summer storm in the Beaufort in September 2000 developed waves 6-7 m high at Point Barrow (Lynch et al., 2003). Such large waves would undoubtedly induce energetic stress, or worse, in any swimming bears unfortunate enough to be caught in them.

Polar bears are excellent swimmers and swim while actively hunting, while moving between hunting areas, and while moving between sea ice and terrestrial habitats. In June, 2005, USGS researchers identified a female polar bear which apparently swam for over 557 km from Norton Sound back to the retreating pack ice in the Chukchi Sea northwest of Wainwright (Amstrup et al., 2006). Swimming is believed to be more energetically costly than walking, which helps explain why bears will often abandon the melting sea ice in favor of land when ice concentrations drop below 50% (Derocher, Lunn, and Stirling, 2004). Polar bears also can become energetically stressed when the pack ice retreats and carries them to deeper waters beyond the productive continental shelf zone. These bears eventually may choose to swim for shore, where annual food resources such as subsistence-harvested whale carcasses can be found along the coast. Despite being strong swimmers, energetically stressed bears are susceptible to misfortune on such long-distance swims. For example, Monnett and Gleason (2006) reported unprecedented polar bear mortalities following a severe storm event in the Beaufort Sea in fall 2004. They estimated that at least 27 bears may have died as a result of this one storm, and attributed this phenomenon to longer open water periods and reduced sea ice cover. If such events are recurrent, they could easily rise to the level of a significant impact upon polar bear populations, especially considering that current human removals are already believed to be at or above maximum sustainable levels.

Additionally, polar bear use of coastal areas during the fall open-water period has increased in recent years (Kochnev et al., 2003; Schliebe et al., 2005). In fact, nearshore densities of polar bears can be two to five times greater in autumn than in summer (Durner and Amstrup, 2000). For example, aerial surveys flown in September and October from 2000-2005 have revealed that 53% of the bears observed along the coast have

been females with cubs, and that 73% of all bears observed were within a 30-km radius of the village of Kaktovik, on the edge of the ANWR (Schliebe et al., 2005). Congregations of more than 60 polar bears and as many as 12 brown bears have been observed feeding on whale carcasses near Kaktovik in recent years during the fall open-water period (Miller, Schliebe, and Proffitt, 2006), and as many as 140 polar bears have been observed at walrus haul-out sites on Wrangel Island and the north coast of Chukotka (Kochnev, 2002; Kochnev et al., 2003). These observed changes in polar bear distribution have been correlated with the distance to the pack ice at that time of year. The farther from shore the leading edge of the pack ice is, the more bears are observed onshore in fall (Kochnev et al., 2003; Ovsyanikov, 2003; Schliebe et al., 2005; Kochnev, In prep.).

Sport hunting for polar bears has been banned in Alaska since 1972, although bears are still taken for subsistence, recreation, and handicrafts by Alaskan Natives. In 1988, the Inuvialuit Game Council from Canada and the North Slope Borough from Alaska implemented the Polar Bear Management Agreement for the Southern Beaufort Sea, a voluntary agreement that limited the total harvest from the SBS population to within sustainable levels (Brower et al., 2002). The stipulations contained in this voluntary agreement actually are more stringent than those contained in the MMPA. Sustainable quotas under the agreement are set at 80 bears per year, no more than 27 of which may be female. This quota is believed to be at or near sustainable levels, although recent population estimates (Regehr et al., 2006) call that assumption into question. Recent harvest levels (2000-2005) from the SBS stock averaged 37 individuals in the U.S. and 25 individuals in Canada, for an average harvest of 62 bears per year, well within the agreement's quotas (USDOI, FWS, unpublished data). For the same period, reported U.S. harvest levels of the CBS stock averaged 41 bears, while average Russian harvests of the CBS stock are believed to be much higher (Ovsyanikov, 2003; USDOI, FWS, 2003; USDOI, FWS, unpublished data).

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

A reliable estimate for the CBS stock of polar bears, which ranges into the southern Beaufort Sea, does not exist, and its current status is in question. In 2002, the IUCN/SSG Polar Bear Specialist Group estimated the size of the CBS population at 2000+ bears, though the certainty of this estimate was considered poor (Lunn, Schliebe, and Born, 2002). Russia prohibited polar bear hunting in 1956 in response to perceived population declines; however, both sport and subsistence harvest continued in Alaska until 1972. During the 1960's, hunters took an average of 189 bears per year from the CBS population, an unsustainable rate of harvest that likely caused significant population declines. With the passage of the MMPA in 1972, which prohibited sport hunting of marine mammals, the average annual Alaska harvest in the Chukchi Sea dropped to 67 bears per year. However, with the collapse of the Soviet empire in 1991, levels of illegal harvest dramatically increased in Chukotka in the Russian Far East (Amstrup, 2000; USDOI, FWS, 2003). While the magnitude of the Russian harvest from the CBS is not precisely known, some estimates place it as high as 400 bears per year, although the figure is more likely between 100 and 250 bears per year. Models run by the FWS indicate that this level of harvest of the CBS population is most likely unsustainable, and that an average annual harvest of 180 bears (4.5% of the starting population) could potentially reduce the population by 50% within 18 years (USDOI, FWS, 2003). This simulated harvest level is similar to the estimated U.S./Russia annual harvest for the period 1992-2006, as well as to the unsustainable harvest levels experienced in Alaska in the 1960's, indicating that the CBS stock of polar bears may well be in decline due to overharvest. The FWS calculations were based on a starting population of 4,000 bears, which is believed to fairly characterize a *healthy* CBS population. However, because of the unknown rate of illegal take currently taking place, in 2006 the IUCN/SSG Polar Bear Specialist Group designated the status of the CBS stock as "declining" from its previous estimate of 2000+ animals (IUCN/SSG Polar Bear Specialist Group, 2006).

When environmental factors result in minimal ice conditions, it may affect polar bear-hunting success. In these situations, walrus haulouts become important feeding resources during autumn. The abundance and predictable nature of available food resources at haul outs contributes to long-term aggregations of polar bears. Considering the regular nature of such aggregations, they likely play an important role in habitat use patterns of individual bears and their progeny (Kochnev, In prep). According to Nikita Ovsyanikov, deputy

director and senior research scientist of the Wrangel Island Nature Reserve, the summer and fall 2002 were particularly bad for polar bears in the Chukchi Sea. Due to poor ice conditions, many polar bears hunting near Wrangel Island were forced ashore in “starving” condition. During such open-sea situations seals, the polar bears main prey, become unavailable and bears are forced to turn to walrus for sustenance. However, walrus did not haul out on Wrangel Island in autumn 2002 as they usually do; as a consequence, the stranded bears suffered a high mortality rate (Ovsyanikov, 2003).

Due to ice patterns and prevailing winds, many walrus and a relatively large number of polar bears can land on the north coast of Chukotka during late summer and autumn. Many walrus can die in stampedes, which may be caused by Native hunters that, in turn, provides scavenging opportunities for stranded bears (Ovsyanikov, 2003) and brings them into close proximity to Native villages. As a result, the illegal harvest of polar bears on the Chukotka coast was higher in 2002 than during any previous years, with approximately twice the usual illegal take. Experts estimate that the illegal polar bear take in Chukotka in 2002 was between 250 and 300 animals (Ovsyanikov, 2003). The recent illegal polar bear take in Chukotka has little to do with traditional subsistence; rather, it appears to be purely for illegal commercial use (Ovsyanikov, 2003). As discussed above, this level of mortality is not sustainable, and highlights the peril that the CBS polar bear stock is currently in. The fact that more bears are visiting the northern coast of Chukotka does not reflect an increase in the number of polar bears, but rather the growing impact on bears from the reduced sea ice cover in the summer and autumn (Ovsyanikov, 2003).

Not less than seven to eight beach-cast whales occur annually along the Chukotka coast (Kochnev, In prep) and, in the last 10-15 years, the number of observations of polar bears feeding on marine mammal carcasses along the coast has increased (Kochnev et al., 2003). Such aggregations have occurred repeatedly (Kochnev, In prep). Bear concentrations form on the coast as early as late summer, depending on patterns of ice breakup, and the bears generally concentrate at walrus haulout sites (Kochnev, In prep). In recent years, as many as 50 bears congregated on Kolyuchin Island between August and November (Kochnev et al., 2003; Kochnev, In prep), and from 7-20 bears concentrated in five other areas along the north coast of Chukotka (Kochnev, In prep). In Chukotka, bears appear in great numbers along the coast near the Native village of Vankarem in October and November. These bears frequently come into the village while moving along the coast, where they are attracted by the smell of native harvested walrus meat. Hunters say that as many as 10 bears a day can enter the village (Kochnev et al., 2003).

Over the last 15 years, when the ice edge retreated far to the north of Wrangel Island, walrus formed large haulouts on Somnitel'naya Spit and Cape Blossom on Wrangel Island, where panic stampedes caused mortality from crushing of between 24 and 104 walrus/year. The walrus carcasses, in turn, attract coastal aggregations of bears that usually peak in the second half of October (Kochnev, In prep). Bears appear near walrus rookeries on Wrangel Island in early August, which is about a month prior to when walrus arrive (Kochnev, 2002). The maximum number of bears coming ashore on Wrangel Island most frequently occurs in late October, with an average of 50 bears, and a maximum of 140 bears (Kochnev, 2002). Bear densities can approach 69 bears per square kilometer. The total mass of dead walrus available (from predation and stampede deaths) averages 27 tons per season. This is the most important resource for bears on the island in autumn and early winter (Kochnev, 2002). The correlation between bear numbers and increased distance to the pack ice during the autumn indicates that the magnitude of bear concentrations on land depends on the Chukchi and East Siberian sea-ice condition (Kochnev, In prep). The position of Wrangel Island, an isolated land mass at high latitudes in the Chukchi Sea, contributes to observed use patterns by walrus and polar bears ((Kochnev, In prep).

From 10-13 walrus-haulout sites occur annually in the summer and autumn on the arctic coast of Chukotka. In addition, not less than seven to eight beach-cast whales occur annually (Kochnev, In prep). From 1999 through 2004, bears continued forming large aggregations on the coast of Wrangel Island, although walrus numbers and mortality rates at haulout sites decreased (Kochnev, In prep). On the American side of the Chukchi, walrus haulout sites are very rare (Kochnev, In prep).

In 2006, the SBS population was estimated at ~1,526 individuals (Regehr et al., 2006), down from previous estimates of ~1,800 animals (Lunn et al., 2002).

Neither the SBS nor the CBS stock is listed as “depleted” under the MMPA. The SBS is assumed to be within optimum sustainable population levels, although new information puts that assumption in question

(USDOJ, FWS: <http://alaska.fws.gov/fisheries/mmm/polarbear/reports.htm>). The SBS is currently designated a “non-strategic stock” by the FWS. Due to the lack of information concerning the CBS population, and due to the high levels of illegal harvest, the IUCN/SSG Polar Bear Specialist Group has designated it as “declining.”

III.B.7. Terrestrial Mammals.

Among the terrestrial mammals that occur in the Chukchi Sea area, 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 Chukchi Sea development.

III.B.7.a. Caribou.

Among the terrestrial mammals that occur along the coast of the Chukchi Sea, barren-ground caribou is the species that could be affected most by proposed OCS oil and gas activities in the Chukchi Sea multiple-sale area. One large and two smaller caribou herds use habitats of Alaska’s Arctic plain in the project area: the Western Arctic, the Central Arctic, and the Teshekpuk Lake herds.

III.B.7.a(1) Population Status and Range. The Western Arctic herd (WAH) ranges over approximately 140,000 mi² in northwestern Alaska from the Chukchi coast east to the Colville River, and from the Beaufort coast south to the Kobuk River (Dau, 2005). 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. Since 1996, much of the WAH has shifted its winter range from the Nulato Hills to the eastern half of the Seward Peninsula, and has generally been more dispersed than prior to that time (Dau, 2005). In 1970, the WAH numbered ~242,000 caribou. By 1976, it had declined to about 75,000 animals. From 1976-1990, the WAH grew by 13% annually, and from 1990-2003 growth had declined to 1-3% annually. In 2003, the WAH was estimated at >490,000 animals (Dau, 2005). Sutherland (2005) estimated that local residents harvest ~14,700 WAH caribou annually.

The Teshekpuk Lake Caribou Herd (TCH) is found primarily within the NPR-A, with its summer range extending between Barrow and the Colville River. In some years, most of the TCH 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 WAH. The TCH was estimated to number more than 28,000 animals in 1999 (Bente, 2000). The TCH has increased at a rate of 14% per year between 1989 and 1993 and since then has stabilized or increased slightly (Bente, 2000). In 2002, the TCH was estimated at approximately 45,166 caribou (Carroll, 2005).

The Central Arctic Herd (CAH) has grown from an estimated 5,000 animals in 1975 (Cameron and Whitten, 1979) to about 31,857 animals in 2002 (Lenart, 2005a). Although the CAH traditionally calved between the Colville and Kuparuk rivers on the west side of the Sagavanirktok River and between the Sagavanirktok and the Canning rivers on the east side, the greatest concentration of caribou calving has shifted southwest as oil-field development occurred in those areas (Lawhead and Johnson, 2000; Lenart, 2005a). The CAH’s range extends from the Itkillik River east to the Canning River, and from the Beaufort coast south into of the Brooks Range. Its summer range extends from Fish Creek, just west of the Colville River, eastward along the coast (and inland approximately 30 mi) to the Katakaturuk River. The CAH winters in the foothills and mountains of the Brooks Range. It often overlaps with the Porcupine caribou herd on summer and winter range to the east and with the WAH and TCH herds on summer and winter range to the west (Lenart, 2005a).

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, potentially leading to drastic, long-term population declines. 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 TCH 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 later. Severe weather and deep snow can delay spring migration, with some calving occurring en route (Carroll et al., 2005). Cows calving en route usually proceed to their traditional calving grounds (Hemming, 1971).

Traditional calving grounds consistently provide 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 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; Griffith et al., 2002). 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). The WAH calving area is inland on the NPR-A, west of the Proposed Action area. Typically, most pregnant cows reach the calving grounds by late May. Most give birth in the Utukok uplands during late May through early June. By mid-June large postcalving aggregations begin forming as cows with neonates move west toward the Lisburne Hills (Dau, 2005). The TCH's central calving area generally is located on the east side of Teshekpuk Lake and near Cape Halkett, adjacent to Harrison Bay. The CAH generally calves within 30 km 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.

During the postcalving period in July through August, caribou generally attain their highest degree of aggregation with continuous masses of animals in herds, sometimes 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. In the postcalving period (July through August), caribou attain their highest degree of aggregation. 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). Members of the WAH may be found in continuous herds numbering in excess of tens of thousands of individuals, and portions of the WAH 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 TCH 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 km south of Teshekpuk Lake (Hemming, 1971; Philo, Carroll, and Yokel, 1993). Caribou aggregations move frequently from insect-relief areas along the arctic coast (the CAH, WAH, and especially the TCH) and in the mountain foothills (some aggregations of the WAH) to and from green foraging areas.

III.B.7.a(5) Winter-Range Use and Distribution. The WAH 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 WAH is located south of the Brooks Range along the northern fringe of the boreal forest. Since 1996, much of the WAH has shifted its winter range from the Nulato Hills to the eastern half of the Seward Peninsula, and has generally been more dispersed than prior to that time (Dau, 2005). However, in recent winters, >30,000 WAH caribou have wintered in the northwest portion of their range. During two of these winters (1994-1995 and 1999-2000) caribou wintering along the Chukchi Sea coast between Cape Lisburne and Cape Krusenstern experienced high, localized mortality. Investigation indicated that caribou in this area were malnourished (Dau, 2005). 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 WAH overwinter on the Arctic Coastal Plain. The TCH 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 CAH 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; 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 on the Arctic National Wildlife Refuge (ANWR) in 1969 and in the Kavik River area (between Prudhoe Bay and the Refuge) in 1970; they were reintroduced west of the NPR-A near Cape Thompson in 1970 and 1977 (Smith, 1989). The reintroductions to the east established the ANWR population, which grew rapidly and expanded both east and west of the Refuge (Garner and Reynolds, 1986). North slope muskoxen are found as far east as the Babbage River in northwestern Canada and as far west as the Kogru River. Common drainages where muskoxen have been observed include the Colville, Itkillik, Kuparuk, Sagavanirktok, Canning, Sadlerochit, Hulahula, Okpilik, Jago, and Aichilik rivers (Lenart, 2005b). There are muskoxen west of Prudhoe Bay as far as Fish Creek in northern NPR-A and quite a few in the Itkillik Hills south of Kuparuk all the way to the Colville River. There also was a major release at Cape Thompson on the Chukchi that resulted in muskoxen expanding northward into the western Brooks Range, and that herd appears to be doing well (D. Shideler, 2006a, pers. commun.). The number of muskoxen that occur within the Proposed Action is unknown. In 1998, a total of about 800 muskoxen were observed in the 500-km area between the Itkillik River west of Prudhoe Bay and the Babbage River in northwestern Canada (Reynolds, 1998). By 2005, ADF&G estimated that there were 450-550 muskoxen in eastern Alaska and northwestern Canada, and that it is probable that the trend will continue downward (Lenart, 2005b). Probably a transitory number of lone bulls frequent the Proposed Action area, coming from populations that breed east of the Colville River. The most important habitats for muskoxen appear to be 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).

III.B.7.c. Grizzly Bear.

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 mi², with a mean density of 1 bear per 100 mi². The number of grizzly bears between the Colville and Canning rivers adjacent to the central Beaufort Sea area increased in the 1990's due to the presence of anthropogenic food sources associated with oil development. However, mortality from removal of problem bears and from hunting along the Dalton Highway and rural communities reduced these bears, resulting in a local population that is stable or slightly declining (Shideler, 2006b, pers. commun.). An estimated 60-70 bears or approximately 4 per 1,000 km² currently inhabit the central North Slope Coastal Plain (Shideler and Hechtel, 2000). Since 1990, the ADF&G has captured and marked 121 bears between Teshekpuk Lake and the Canning River while studying the bears' use of the oil fields (Shideler, 2006b, pers. commun.). These bears have very large home ranges (201-13,880 km² (Shideler, 2006b, pers. commun.) and travel up to 50 km a day (Shideler and Hechtel, 2000). 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 2000). Bears on the North Slope enter dens primarily in the last 2 weeks of September through early November and emerge from the dens in mid-April to early June, with adult males entering dens the latest and emerging the earliest (McLoughlin, Cluff, and Messier, 2002; Shideler and Hechtel, 2000). In 1992, the estimated population for Game Management Unit 26A, the area west of the Itkillik River and which includes all of NPR-A, was 900-1,120 bears (Carroll, 2005). There have been no surveys since that time, but the population appears to be stable. Grizzly bears in the western Brooks Range use a variety of food sources including seasonally the WAH, beach-cast marine mammal carcasses and, to some degree, seasonal salmon and char runs that occur in major Chukchi coast drainages.

III.B.7.d. Arctic Fox.

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.

The description of vegetation in the study area is based on studies conducted by the Circumpolar Arctic Vegetation Mapping Team (2003). Vegetation types described in this section are circumscribed to an area between the shoreline and an assumed boundary of about 50 km inland (Fig. III.B-9), such area encompasses about 6,500,000 acres. The assumption is that most activities from the Proposed Action will not extend beyond the delineated area. Vegetation physiognomy in the area of study is tightly related to summer temperatures. The amount of warmth available to plants during the summer does increase from north to south across the Arctic and so does the complexity and development of vegetation. In the study area, vegetation changes from mainly creeping dwarf shrubs of <5 cm in height where mean July temperatures are about 3-5 degrees Celsius (°C) (Subzone B), to areas where dwarf shrubs reach about 15 cm tall where mean July temperatures are between 5 and 7 °C (Subzone C), followed by vegetation reaching up to 40 cm tall (mean July temperatures of 7-9 °C) in subzone D. At warmer mean July temperatures (9-12 °C), vegetation reaches about 50 cm tall, sometimes with a layer of low shrubs of about 80 cm high (Subzone E).

The following paragraphs describes the most common vegetation types found within 50 km inland from the Chukchi Sea shoreline:

III.B.8.a. Sedge, Moss, Dwarf-Shrub Wetland (W2).

These wetlands are the most abundant within the 50-km belt and cover about 41% of the area. They are described as wetland complexes established in the milder areas of the Arctic, usually in bioclimate subzone D. An interrupted, closed vegetation cover is characterized by the dominance of graminoids (sedges and grasses) and dwarf shrub layers reaching about 40 cm tall. Mosses also are abundant and form thick layers of about 5-10 cm deep. Sedge species include water sedge, cordroot sedge, loose flower alpine sedge, tall cottongrass, and *Eriophorum triste*. The grass component is dominated by pendant grass and *Dupontia psilosantha*. Mosses include *Pseudocalliergon brevifolius*, *Scorpidium scorpioides*, *Cinclidium latifolium*, *Meesia triquetra*, *Catascopium nigratum*, and *Distichium capillaceum*. The dwarf-shrub layer is dominated by creeping willows such as arctic willow, *S. reptans*, and *S. fuscescens* and forbs like fernweed, *Potentilla penellii*, and Marsh fivefinger. Dwarf shrubs are present in raised acidic microsites with Labrador tea, diamond leaf willow, crowberry, dwarf birch, and blueberries (*Vaccinium* sp) as dominant species.

III.B.8.b. Tussock Sedge, Dwarf Shrub, Moss Tundra (G4).

This vegetation type covers approximately 24% of the area, the second most abundant within the 50-km belt. This plant community, classified as moist tussock tundra, is found in cold acidic soils, usually on bioclimate subzone E on unglaciated areas with ice-rich permafrost and shallow active layers. Vegetation covers about 80-100% and reaches between 20 and 40 cm tall. On subzone D, this vegetation type is not as vigorous, with smaller tussock sedges and shorter shrubs that expose the tussock microrelieve. Dominant species include tussock sedges (*Eriophorum vaginatum* and *Carex lugens*) and nontussock sedges (*Carex bigelowii* and *Eriophorum triste*). Shrubs include not only creeping plants but also erect dwarf shrubs including Labrador tea, dwarf birch, diamond leaf willow, mountain cranberry, bog blueberry, alpine bearberry, cloudberry, alpine nagoonberry, and dwarf dogwood. Mosses are abundant and include *Sphagnum* sp., *Hylocomium splendens*, *Oncophorus wahlenbergii*, *Aulacomnium turgidum*, *Dicranum*, and *Polytrichum*. Forbs also are abundant. Typical forbs include Lapland lousewort, Bistort, Cordate-leaved saxifraga and sweet coltsfoot among others. Common lichens include *Flavocetraria*, *Cladina rangiferina*, *Cladonia amaurocraea*, *Ochrolechia frigida*, *Alectoria nigricans*, and *Bryocaulon divergens*.

III.B.8.c. Sedge/Grass Moss Wetland (W1).

This vegetation type covers approximately 9% of the area evaluated within the 50-km belt. The plant community is established in standing water; low, wet areas; and moist, elevated microsites in bioclimatic subzones B and C. It is characterized by the dominance of creeping evergreen dwarf shrubs and up to 60% of the substrate covered with cryptogams (lichens, mosses, etc.). Dominant species include sedges such as water sedge, *Eriophorum triste*, and *E. scheuchzeri*. Grasses such as Pendant grass, boreal alopecurus, sabbule grass, Fisher's tundra grass, and Kentucky bluegrass also are abundant. Mosses such as *Calliergon giganteum*, *Warnstorfia sarmentosa*, *Cinclidium arcticum*, and *Hamatocaulis vernicosus*, among others, are also common. Well-represented forbs include cuckoo flower, Regel's chickweed *Cerastium regelii*, marsh marigold, alpine bistort, nodding Saxifrage, leafy-stream saxifrage, and fernweed.

III.B.8.d. Erect Dwarf-Shrub Tundra (S1).

This vegetation type covers approximately 8% of the area evaluated within the 50-km belt. This tundra community is dominated by erect dwarf-shrubs, mostly <40 cm tall, established on acidic soils (subzone D). Plant cover varies from an 80-100% cover. On dry ridges, a drier, lichen-rich dwarf-shrub tundra is commonly established, but the plant cover is sparse (5-50%). Sedges are an important component of the herbaceous layer, with dense low to tall shrublands along streams and drainage ways. Dominant species of the dwarf-shrub component includes dwarf birch, bog blueberry, mountain cranberry, Labrador tea, crowberry, greyleaf willow, and white arctic mountain heather. Mosses include *Hylocomium splendens*, *Aulacomnium turgidum*, *Dicranum*, and *Racomitrium lanuginosum*. Lichens include *Stereocaulon*, *Cladonia*, *Flavocetraria*, *Alectoria ochroleuca*, *Masonhalea richardsonii*, and *Bryocaulon divergens*, among others.

III.B.8.e. Nontussock Sedge, Dwarf-Shrub, Moss Tundra (G3).

This vegetation type covers approximately 6% of the area evaluated within 50-km belt. This is a moist tundra plant community established on peaty, nonacidic soils, usually in subzones D, C, and some E. Barren patches due to frost boils and periglacial features are common. Plant cover is about 50-100 %. Although vegetation is dominated by nontussock sedges and dwarf shrubs with heights generally 10-20 cm, in some localized areas it reaches 40-200 cm in height, with willow thickets more than 2 m tall along steam margins. A well-developed moss layer is typical in this vegetation type.

III.B.8.f. Noncarbonate Mountain Complex (B3).

This vegetation type covers approximately 6% of the area evaluated within the 50-km belt. This vegetation is established on dry, acidic tundra complexes on mountains and plateaus with noncarbonate bedrock. Elevational gradients provide similar summer temperature variations to those observed in bioclimatic subzones, responding with similar vegetation physiognomy. Mesic microsites are relatively uncommon, with most plant communities growing on wind-swept, rocky ridges, screes, and dry fell-fields, alternating with snowbed plant communities.

III.B.8.g. Carbonate Mountain Complex (B4).

This vegetation type covers approximately 4% of the area evaluated within the 50-km belt. This vegetation is established on dry, calcareous tundra complexes on mountains and plateaus with limestone and dolomite bedrock. As in B3, elevational gradients provide similar summer temperature variations to those observed in bioclimatic subzones, responding with similar vegetation physiognomy.

III.B.8.h. Sedge, Moss, Low-Shrub Wetland (W3).

This vegetation type covers approximately 1% of the area evaluated within the 50-km belt. These wetlands are found in warmer areas of the Arctic, usually in bioclimatic subzone E. Dominant plant communities are established in bog/fen complexes with deep organic soils. Plant composition is somewhat similar to W3 vegetation, but usually taller than 40 cm in height. Low shrubs more than 40 cm tall are found in slightly elevated microsites, and sedges and mosses are found in lower, wetter sites.

III.B.8.i. Low-Shrub Tundra (S2).

This vegetation type covers approximately 1% of the area evaluated within the 50-km belt. This tundra community is characterized by low shrubs >40 cm tall, usually found in warmer sites and well-drained uplands. This vegetation is typical in bioclimate subzone E with permafrost free soils, although it is common to find permafrost in peatlands and wet areas.

III.B.8.j. Estuarine Wetlands.

Estuarine wetland systems are found along the Chukchi Sea shoreline in enclosed and protected bays, which are partly obstructed, or with sporadic access to the open ocean (Cowardin et al., 1979). Large estuarine wetland complexes are found in Omalik Lagoon, Kasegaluk Lagoon, Icy Cape, Peard Bay, and Wainwright Inlet. These wetlands typically range from sandy/silt flatlands to emergent persistent wetlands dominated by several sedge species adapted to brackish-water conditions. These wetlands are classified as estuarine intertidal emergent persistent wetlands, estuarine intertidal unconsolidated shores, estuarine intertidal aquatic beds, or estuarine subtidal unconsolidated bottoms. Most of the intertidal biota of the Arctic is impoverished due to the effect of annual ice and the minimal tidal amplitude, so there is almost no littoral biota and few marine wetlands. Genera that are normally intertidal elsewhere in the world are found in the Arctic in subtidal ecosystems. Eelgrass (*Zostera marina*) occurs as pure stands in protected bays, inlets, and lagoons with clear water along the Alaska coast as far north as the north shore of the Seward Peninsula. Eelgrass usually is located in marine silts and clay substrates.

III.B.8.k. Rare Plants.

Six species of rare vascular plants are known to occur on the North Slope (Lipkin and Murray, 1997). *Mertensia drummondii* has been found on sand dune habitats along the Kogosukruk River and along the Meade River. *Poa hartzii* is a bluegrass endemic to arctic Alaska, where it is known to occur from the Meade River to the eastern Brooks Range near Lake Peters. It grows on sparsely vegetated, riparian sands, and gravels of active floodplains, especially point bar deposits. *Rumex krausei* is endemic to northwestern Alaska (Cape Thompson and Squirrel River). It grows on wet gravels, silty sands, or clay soils, often in frost-disturbed or solifluction areas. It also can be found in moist to wet sedge-herb meadows and sedge dryas tundra on gravel river terraces and bluffs (Lipkin and Murray, 1997).

Pleuropogon sabinei (sabine grass) is an aquatic grass that rarely occurs between the *Arctophila* and *Carex* vegetation zones in lakes and ponds. In Alaska, sabine grass has an S1 rank (critically imperiled because of extreme rarity with five or fewer occurrences). It has been reported from Ikpikuk River, Harrison Bay, and Kuparuk River. This species also is known to occur in 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 near streams. This species may be precluded from areas farther south by its adaptation to low temperatures.

Erigeron muirii is a northwestern Alaska endemic species reported from Cape Thompson, Anaktuvuk Pass, Sawwon uplands, Toolik Lake, Canning River, and Kongakut River. Typical habitat characteristics are dry, south-facing fell-fields, bluffs, terraces, alluvial fans, gravels and rock outcrops, and ridges in the foothills region. It usually is found in dryas octopetala, prostrate-shrub, forb tundra.

III.C. Social Systems

III.C.1. Economy.

III.C.1.a. Revenues.

III.C.1.a(1) North Slope Borough Revenues. The tax base in the NSB since 1980 has consisted mainly of high-value property owned or leased by the oil industry in the Prudhoe Bay area. Since 1983, NSB oil and gas property tax revenues have exceeded \$180 million annually, peaking at \$240 million in 1985 (Northern Economics, Inc., 2006).

III.C.1.a(2) State Revenues. The State of Alaska revenues budgeted for expenditure varied between \$4.3 billion in 2001 and \$5.6 billion in 2004 (www.legfin.state.ak.us/).

III.C.1.a(3) Federal Revenues. Total Federal receipts of all types, including personal income tax, corporation tax, and other types, varied from \$2.0 trillion in 2001 and \$1.9 trillion in 2004.

III.C.1.b. Employment and Personal Income.

III.C.1.b(1) History of Employment in the NSB. Approximately 70% of the workers in the oil and gas industry on the North Slope commute to permanent residences in Alaska but outside the NSB, 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 NSB is so small as to be statistically negligible.

Table III-C-1 shows estimated jobs by sector for NSB residents only for selected years 1980 to 2003. These data do not include oil and gas employment centered at Prudhoe Bay; these workers, as indicated above, commute to residences outside the NSB.

The NSB 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 education opportunities available through Iisagvik College, has slowly risen. (NSB, 1999)

For a summary description of the NSB employment of residents by sector, North Slope communities in 2003, see Table III.C-2. The NSB government is the largest employer of permanent residents in the NSB (Table III.C-2).

For a depiction of the share of employment by ethnicity and by sector of North Slope residents in 2003, see Table III.C-1. For further detailed description of employment in the NSB see the Economic Profile and Census Report (NSB, 2003, as cited in Northern Economics, Inc., 2006). For further detailed description of historical employment, see Northern Economics, Inc. (2006).

III.C.1.b(2) Unemployment in the North Slope Borough. According to State figures, unemployment in the NSB was 3.5-9.4% from 1975-2001 (www.labor.state.ak.us/research). However, according to the 1993 NSB Census, 22% of the NSB's resident labor force believed themselves to be underemployed, and 24% worked fewer than 40 weeks in 1993 (NSB, 1995). According to the State Department of Labor, the NSB had 16% unemployment in 1998. According to the 1998 NSB Census, 13% of the NSB's resident labor force perceived themselves to be underemployed and 27% worked fewer than 40 weeks in 1998 (NSB, 1999).

III.C.1.b(3) 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 for employment. This historical information is relevant to assessing potential economic effects of proposed oil and gas exploration and development and on the North Slope Native population. A study contracted by MMS shows that 34 North Slope Natives interviewed constituted half of all North Slope Natives who worked at Prudhoe Bay in 1992, and that the North Slope Natives employed at Prudhoe Bay comprised <1% of the 6,000 North Slope oil-industry workers (USDOI, MMS, 1992). This pattern is confirmed by 2003 data showing only 23 NSB Inupiat residents as employed in the oil industry (see Table III.C-2).

One of the NSB's main goals has been to create employment for Native residents. It has been successful in hiring many Natives for the NSB's construction projects and operations. The NSB has tried to facilitate employment of Native people in the oil industry at Prudhoe Bay. The NSB is concerned that the oil industry has not done enough to train unskilled laborers or to allow them to participate in subsistence hunting. The NSB also is concerned that the oil industry recruits using methods common to western industry. The NSB would like to see industry make serious efforts to hire NSB residents (Nageak, 1998).

The purpose of BPXA's *Itqanaiyagvik* Program is to increase NSB Native employment. It is a joint venture with the Arctic Slope Regional Corporation and its oilfield subsidiaries and is being coordinated with the NSB and the NSB's School District (BPXA, 1998). Nanook Incorporated, a subsidiary of Kuukpik Corporation, based in Nuiqsut, has a training program that could be used to train Natives for position 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, 2003a).

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 oil-industry work in 1969, first as a roustabout, 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, 2003a).

III.C.1.b(4) Most North Slope Oil-Industry Workers Reside Outside the North Slope Borough. 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. Table III.C-3

shows employment in the Anchorage-MatSu Region, the Kenai Peninsula Borough, Fairbanks North Star Borough, and all of Alaska.

III.C.1.b(5) U.S. Employment. The total employment in the U.S. was 127 million workers in 2003 (www.bls.gov/oes/2003/). This employment figure is comparable to employment figures described above.

III.C.1.b(6) Personal Income. Aggregate personal income in 2003 billions of dollars (www.bea.doc.gov/bea/regional/) was: (1) North Slope Borough, \$0.3; (2) Southcentral Alaska (Municipality of Anchorage, Matanuska-Susitna Borough, and Kenai Peninsula Borough) and Fairbanks Northstar Borough, \$16.3; (3) Alaska, \$21.5; and (4) U.S., \$9,329.

Per capita personal income, rounded to the nearest thousand dollars in 2003 (www.bea.doc.gov/bea/regional/) was: (1) North Slope Borough, \$37,000; (2) Municipality of Anchorage, \$38,000; (3) Matanuska-Susitna Borough, \$29,000; (4) Kenai Peninsula Borough, 29,000; (5) Fairbanks Northstar Borough, \$31,000; (6) Alaska, \$33,000; and (7) U.S., \$31,000.

III.C.1.c. Subsistence as a Part of the NSB Economy.

The predominately Inupiat residents of the NSB traditionally have relied on subsistence activities. Although not fully part of the cash economy, subsistence hunting is important to the NSB's whole economy and even more important to the culture (see Secs. III.C.2 and III.C.E). 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.

III.C.2. Subsistence-Harvest Patterns.

III.C.2.a. Subsistence Defined.

The term "subsistence" has different definitions and meanings (Davidson, 1974; Arnold, 1978; Lewis, 1978; Lonner, 1980; Kelso, 1981, 1982; Case, 1984, 1989; Berger, 1985; Caulfield and Brelsford, 1991; Bryner, 1995; Naiman, 1996; ADNRR, 1997; Loescher, 1999). Generally, subsistence is considered hunting, fishing, and gathering for the primary purpose of acquiring traditional food. The Alaska National Interest Land Conservation Act (ANILCA) 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).

All definitions of subsistence emerge from a complicated legislative and social history. Beyond the current Federal and State debate over the constitutional status of subsistence priorities, ANILCA provides the operational basis for defining the term subsistence in this analysis (even though it has been ruled to apply only to onshore Federal lands and waters in Alaska, and not to offshore waters) (USDOJ, FWS, 1992; Hulen, 1996a,b). The analytical framework ANILCA constructs is the basis of all current documentation of Alaskan subsistence activity, both by the State and Federal governments. The dispute is not about the nature of "subsistence activities", but rather (1) who qualifies as a "subsistence user" in terms of a priority for use of subsistence resources; and (2) to a lesser extent, which resources are "subsistence stocks." For the State, all Alaska residents are potentially qualified subsistence users; for the Federal Government, only rural Alaska residents are potentially qualified subsistence users. Areas of Alaska classified as "non-rural" include Anchorage, Fairbanks, the Northstar Borough, the Juneau area, Valdez, the Ketchikan area, and the Wasilla area. Until very recently, portions of the Kenai Peninsula were also classified as "non-rural."

In addition to ANILCA, other legislative acts and regulatory actions relevant to the understanding of subsistence management of Federal lands include the Federal Subsistence Management Regulations (36 CFR 242 or 50 CFR 100; as summarized and available in USDOJ, FWS, 1999b), the Federal Advisory Committee Act, and the Federal Advisory Committee Management Regulations (41 CFR 101-6). The Marine Mammal Protection Act and Endangered Species Act also are pertinent, addressing the harvest of marine mammals, which currently are restricted to subsistence use by coastal Natives.

Examples of subsistence resources potentially affected by OCS activities are marine mammals (bowhead and beluga whales, seals, and walrus); fish; caribou; and waterfowl. For some resources in certain areas, the Federal Subsistence Board (FSB) has determined that all rural Alaska residents are qualified subsistence users. For other resources, the FSB has made more restrictive “customary and traditional” determinations of eligibility. To show customary and traditional use of a specific subsistence resource, a community or area is evaluated in terms of several factors. These include:

- time, depth, and consistency of its use;
- seasonal repetition of use over many years;
- efficiency in terms of effort and cost of use;
- consistency of the harvest or use of fish and wildlife in proximity to the community or area;
- historic or traditional means of handling, preparing, preserving, and storing fish and wildlife that have been used by past generations;
- intergenerational transmission of hunting and fishing skills, values, and knowledge;
- sharing and distribution of the harvest;
- dependency on a wide variety of fish and wildlife resources available in an area; and
- provision of substantial cultural, economic, social, and nutritional elements to the community or area.

III.C.2.b. The Cultural Importance of Subsistence.

“Subsistence” as a label incorporates a complex set of behaviors and values that extends far beyond the harvesting and consumption of wild resources, even though it is formally defined primarily in those terms. The North Slope Borough Municipal Code (NSBMC) 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” (NSBMC 19.20.020 (67)). Harvest and consumption are merely the most visible aspects of such a system, and the most logical entry point for examining a social system with a subsistence ideology. The fundamental values of such societies are expressed in the *idiom* of subsistence, so that kinship, sharing, and subsistence resource use behaviors (i.e., harvest, processing, preparation, consumption, and celebration) become inseparable (Langdon and Worl, 1981; Elanna and Sherrod, 1984). Worl (1979) and Nelson (1979) describe subsistence as a central focus of North Slope personal and group cultural identity. Hopson (1976, 1978) establishes the political and ideological power of subsistence as an organizing concept for the NSB.

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. Because many species are important for the role they play in the annual cycle of subsistence-resource harvests, and 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 these foods helps maintain ties with family members elsewhere in Alaska.

Communities express their unique identities based on their enduring connections between current residents, those who used the areas in the past, and the wild resources of the land. Elder’s conferences, spirit camps, and other information exchange and gathering events serve to solidify these cultural connections between generations, and between the people and the land and its resources.

Many studies have examined the relationship between subsistence and wage economies and how subsistence and wage activities are integrated into rural Alaskan socioeconomic systems. General theoretical and conceptual treatments are available in Wolfe et al. (1983, 1984) and Impact Assessment, Inc. (1988). Although not always explicitly stated, rural communities and rural socioeconomic systems are not all the same. One salient variable is the ethnic composition of the community; another is the diversification of the local economy and the availability of wage employment. An extensive study series

was conducted across a wide range of Alaskan communities during the 1980's that focused on local patterns of wild resource use as a component of the overall economy (Galginaitis et al., 1984; Reed, 1985; Sobelman, 1985; Impact Assessment, Inc., 1989; Stratton, 1989, 1990, 1992). Additional community-specific studies are cited in Fall and Utermohle (1999). Some of these communities are predominantly Native, others are predominantly non-Native, while others are more ethnically "mixed." Some have developed wage (or self-employment) economies; others have few such opportunities.

Within the NSB, both subsistence activities and wage economic opportunities are highly developed, and highly dependent on each other (Kruse, Kleinfeld, and Travis, 1981; Kruse, 1982, 1991; Harcharek, 1995; Shepro and Maas, 1999). Those individuals most active in subsistence activities tend to be those who are also very involved in the wage economy. That is, monetary resources are needed to effectively assist in the harvest of subsistence resources, both as they affect individual harvesters (e.g., to purchase a boat; snowmachine; four wheeler, or all-terrain vehicle; fuel; and guns and ammunition) or as they affect the head of a collective crew (e.g., for whaling). However, full-time employment also limits the time a subsistence hunter can spend hunting to after-work hours. During midwinter, this window of time is further limited by waning daylight. In summer, extensive hunting and fishing can be pursued after work and without any limitations. As one North Slope hunter observed: "The best mix is half and half. If it was all subsistence, then we would have no money for snowmachines and ammunition. If it was all work, we would have no Native foods. Both work well together" (ACI, Courtneage, and Braund, 1984).

There is evidence that Native subsistence users as a group display a different pattern of use than do non-Natives (e.g., use of different resource species, harvest and consumption of larger quantities, more widespread sharing and distribution of resources), as detailed in Impact Assessment, Inc. (1988) and Human Relations Area Files (1994a,b,c).

Subsistence foods consist of a wide range of fish and game products that have substantial nutritional benefits. They generally are rich in nutrients and low in fats, and they contain more heart-healthy fats and less harmful fats than many non-Native foods (Nobmann, 1997). Subsistence foods also contribute to good health. Social, emotional, spiritual, and cultural benefits are other important aspects of subsistence-food harvesting and sharing that contribute to personal and community health. Rural Alaskans harvest more than 40 million pounds (lb) of wild foodstuffs every year (Wolfe, 1996). On average, food produced through hunting, fishing, and gathering amounts to just over 1 lb of wild edible products per person per day. Harvest data describe the amount of wild food available to a certain group of people, and are a rough estimate of what is eaten. Actual consumption varies from what is harvested or brought into the kitchen. However, few wild-food consumption studies have been undertaken in Alaska.

According to 1990 estimates (Wolfe, 1996), the annual wild food harvest in rural Alaska was 375 lb per person, compared to 22 lb per person in urban Alaska. Assuming that, on average, 0.2 lb of wild food contains 44 grams of protein, and 2.94 lb of wild foods contains 2,400 kilocalories, the amount of wild food harvested in 1990 represented 243% of the rural population's protein requirements and 35% of the population's calorie requirement. In contrast, the food reportedly harvested by urban residents represented 15% of their protein requirements and 2% of their calorie requirements. Clearly, wild foods represent a major source of healthy food in rural Alaska.

III.C.2.c. Subsistence-Harvest Patterns.

This section describes the subsistence-harvest patterns of the Inupiat communities in and adjacent to the Beaufort and Chukchi Sea Planning Areas: Barrow, Atqasuk, Wainwright, Point Lay, Point Hope, and Kivalina, as well as subsistence communities in Chukotka along the Russian Chukchi Sea coast from Uelen northwest toward Cape Billings and Wrangel Island that could be contacted in the event of a large oil spill. 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. The entire marine subsistence-harvest areas of each of the Alaska coastal communities—except Kivalina, where only the northern portion of their marine subsistence harvest area is included and the Chukotkan communities, which are outside the Planning Area boundaries—are included in the Planning Area. Fundamentally, long-term subsistence-harvest practices and subsistence cycles have not changed since the assessment provided in the Multiple-Sale final EIS (USDO, MMS, 2003a); nevertheless, harvest areas can be fluid and change from season to season, and

there is increasing concern over the onset of global climate change and its effects on subsistence seasons and practices. The BLM's Alpine Satellite Development Plan draft EIS for potential expansion of Alpine field production near Nuiqsut (USDOI, BLM, 2004a) has provided new information on contemporary harvest areas in some communities, particularly Barrow and Atqasuk.

Subsistence-harvest pattern information, along with new research on subsistence resources and sociocultural systems that might influence the previous effects' assessments, is summarized below. This summary also includes any new Native stakeholder concerns as they relate to these topics, as well as traditional knowledge updates. The discussions on subsistence-harvest patterns, subsistence resources, and sociocultural systems in the following MMS, BLM, and U.S. Army Corps of Engineers EIS and EA documents are summarized and incorporated by reference: the Liberty Development and Production Plan final EIS (USDOI, MMS (2002), Beaufort Sea Sale 195 EA (USDOI, MMS, 2004), the Arctic Ocean Outer Continental Shelf Seismic Surveys—2006 Programmatic EA (USDOI, MMS, 2006a), the 5-Year Oil and Gas Leasing Program 2007-2012 draft EIS (USDOI, MMS, 2006c); the Bureau of Land Management's (BLM's) Northwest NPR-A final Integrated Activity Plan IAP/EIS (NW NPR-A) (USDOI, BLM and MMS, 2003), Northeast NPR-A Amendment IAP/EIS (USDOI, BLM, 2005), the Kobuk-Seward Peninsula Resource Management Plan (USDOI, BLM, 2006); and the U.S. Army Corps of Engineers' Delong Mountain Terminal Project draft EIS (U.S. Army Corps of Engineers, 2005).

The following summary is augmented by information from past and current studies including: North Slope Borough Contract Staff (1979); Shapiro, Metzner, and Toovak (1979); Schneider, Pedersen, and Libbey (1980); Jacobson and Wentworth (1982); Minn (1982); Nelson (1982); Besse (1983); Hall (1983); Kruse et al. (1983a,b); ACI, Courtneage, and Braund (1984); Braund and Burnham (1984); Luton (1985); George and Kovalsky (1986); George and Nageak (1986); Craig (1987); Hoffman, Libbey, and Spearman (1988); S.R. Braund and Assocs. (1989a,b); Impact Assessment (1989,1990a,b); S.R. Braund and Assocs. and UAA, ISER (1993a,b); Alaska Natives Commission (1994); Lowenstein (1994); Suydam et al. (1994); Stephensen, Cramer, and Burn (1994); ADF&G (1995); City of Nuiqsut (1995); Harcharek (1995); S.R. Braund and Associates (1996); Brower and Opie (1997); Fuller and George (1997); Moulton (1997); Brower and Hepa (1998); Burch (1998); North Slope Borough (1998); Brower, Olemaun, and Hepa (2000); Kassam and Wainwright Traditional Council (2001); U.S. Geological Survey (2002); ADF&G (2004); NMFS (2004); Wolfe (2004); Northern Economics, Inc. (2006). Other sources and pertinent documents include: USDOI, BLM (1978a,b,c; 1979a,b,c,d; 1982a,b,c; 1983a,b; 1990; 1991; 1998a,b,c); and USDOI, MMS (1990a, 1996b,c, 1997, 1998).

III.C.2.c(1) Community Subsistence-Harvest Patterns. Two major subsistence resource categories occur on the North Slope: the coastal/marine and the terrestrial/aquatic. Coastal/marine food resources include whales, seals, walrus, waterfowl, and fish. Terrestrial/aquatic resources include caribou, freshwater fishes, moose, Dall sheep, edible roots and berries, and furbearing animals. Generally, communities harvest resources most available to them. The distribution, migration, and seasonal and more extended cyclical variation of animal populations make decisions on what, where, and when to harvest a subsistence resource very complex. Many areas might be used infrequently, but they can be quite important harvest areas when they are used. Under certain conditions, harvest activities may occur anywhere in the planning area, but they tend to be concentrated along rivers and coastlines, near communities, and at particularly productive sites. Russian Chukotkan communities harvest similar species in similar environments, although Dall sheep are not available and reindeer herding has supplanted wild caribou hunting.

How a village uses a 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, whale use would go down; 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 (animal) resources, such as marine and terrestrial mammals and fish, is heavily emphasized, so the subsistence harvest of vegetation by communities adjacent to the Planning Area is limited. When compared with 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 hunting effort, quantity of meat

harvested, and quantity of meat consumed. The bowhead whale is the preferred meat and 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 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 second or third most important resource after caribou and bowhead whales. Bearded seals and various types of birds are also considered primary subsistence species. Waterfowl are particularly important during the spring, when they provide variety to the subsistence diet. In the late 1970's when bowhead whale quotas were low and the Western Arctic herd of caribou crashed (and the Alaska Board of Game placed bag limits on them), hunters turned to bearded seals (ugruk), ducks, geese, and fish to supplement the subsistence diet (Atqasuk could only turn to the last three resources) (Schneider, Pedersen, and Libbey, 1980). Seal oil from hair seals and 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, Wainwright, Point Hope, and Kivalina. Some Point Lay men whale with crews from Wainwright and some Atqasuk men whale with Barrow crews, and Point Lay, traditionally only hunting beluga whales, has recently pursued obtaining a bowhead whale quota for the community). The sharing of whale muktuk, or fat, and whale meat is important to the inland community of Atqasuk, as well, and continues 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 from the IWC; relatively plentiful supplies of other resources such as caribou, fish, other subsistence foods; and the availability of retail grocery foods. There are regional exceptions to the bowhead whale harvest tradition. In Point Lay, the beluga whale harvest is the mainstay of the community, and most Chukchi Sea communities rely more heavily on the harvest of walrus and seals than do Beaufort subsistence communities.

Whaling traditions include kinship-based crews, use of skin boats (in Barrow and Point Hope; aluminum boats have almost entirely replaced skin boats for Wainwright's spring hunt) for the spring whale-hunting season, distribution of the meat, and total community participation and sharing. In spite of the rising household incomes, these traditions remain as central values and activities for Inupiat on the North Slope. Bowhead whale hunting strengthens family and community ties and the sense of a common Inupiat heritage, culture, and way of life; it provides strength, purpose, and unity in the face of rapid change. Barrow is the only community within the Planning Area that harvests whales in the spring and fall. Wainwright, Point Hope, and Kivalina whale only during the spring season, but some Nuiqsut hunters travel to Barrow to join Barrow whaling crews for spring whaling (North Slope Borough, 1998).

The collapse of Soviet infrastructure in the Russian Far East and Chukotka forced Native Chukotkans to return to subsistence practices that predate Soviet collectivization of reindeer herding, fox farming, and associated whaling practices. In 1994, the NSB Wildlife Management Department signed a cooperative agreement with the Eskimo Society of Chukotka to assist in rebuilding their whaling traditions by supplying them with equipment and weapons to facilitate the gray whale harvest, to assist in annual bowhead whale counts, and in obtaining a bowhead whale quota from the IWC (North Slope Borough, 1997). Whale and walrus hunting is concentrated in the months of July through October but gray whales can be taken in June (North Slope Borough and USDOI, National Park Service, 1999).

In Alaska, an important shift in subsistence-harvest patterns occurred in the late 1960's when the substitution of snow machines for dogsleds decreased the importance of ringed seals and walrus as key sources of dog food and increased the relative importance of waterfowl. This shift illustrates how technological or social change can lead to the modification of 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 and beluga whales, caribou, and fish—the three most important subsistence-food resources to North Slope and Chukchi Sea coastal communities—play in the subsistence harvests of Alaska's Inupiat, and for which there are no practical substitutes.

The subsistence resources used by these communities are listed by common species name, Inupiaq name, and scientific name in Table III-18 in the Northwest NPR-A final EIS (USDOI, BLM and MMS, 2003). For a comparison of the proportion of Inupiat household foods obtained from subsistence in 1977, 1988, 1993, and 1998, see Northwest NPR-A, Table III-19 (see also the Beaufort Sea Sale 144 Final EIS

[USDOJ, MMS, 1996a:Sec. III.C.3]). The percentage of households in Barrow who participate in successful harvests of subsistence resources is shown in Northwest NPR-A, Table III-20 and the percentages of the total subsistence harvest by individual species for each community are shown in NW NPR-A, Table III-17. Relative household consumption of subsistence resources, changes in subsistence activity, and expenditures on subsistence for Wainwright, as determined from a NSB economic profile and census conducted in 1998-1999 (North Slope Borough, 1999) are shown in Northwest NPR-A, Figures III-12, III-13, and III-14, respectively.

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. Additionally, subsistence provides a link to the market economy; many households within the communities earn cash from crafting whale baleen and walrus ivory and from harvesting furbearing mammals.

Subsistence harvest patterns are potentially impacted by oil and gas activities. Inupiat concerns regarding oil development in the Planning Area identified during scoping and public outreach efforts fall into the following categories:

1. Disrupting migrating subsistence species.
2. Damaging subsistence resources and habitats.
3. Altering, interrupting or preventing access to subsistence areas.
4. Tainting or destroying Native food from oil spills.
5. Contaminants in subsistence foods.
6. Degrading traditional Inupiat places.
7. Impacting communities from the cumulative effects of oil development (especially as already seen in the community of Nuiqsut).
8. Failing to sufficiently recognize Inupiat indigenous knowledge concerning subsistence resources, subsistence-harvest areas, and subsistence practices.
9. Failing to develop proper significance thresholds for subsistence resources and sociocultural systems. Failing to provide sufficient baseline data of subsistence species and monitoring of effects.
10. Damaging Inupiat culture from effects to subsistence and stress and anxiety from the threat of possible development activities.
11. Failing to sufficiently analyze climate change as it affects subsistence resources, practices, and communities in the Arctic.

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. 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 concerns heard in the testimony from the North Slope for this period (S.R. Braund and Assocs., In prep.; Kruse et al., 1983:Table 35; USDOJ, MMS, 1994; Human Relations Area Files, Inc., 1992).

III.C.2.c(2) Annual Cycle of Harvest Activities. Annual subsistence cycles for Barrow, Atqasuk, Wainwright, Point Lay, Point Hope, Kivalina, and subsistence communities in Chukotka along the Russian Chukchi Sea coast are summarized below. The subsistence areas and activities of these communities in or near the Planning Area could be affected by the activities evaluated in this EIS. 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. Very few Inupiat live outside the traditional communities, but the seasonal movement to hunting sites and camps for subsistence activities involves travel over and use of extensive areas around these settlements. The aggregate community subsistence-harvest areas for the primary subsistence resources of marine mammals (whales, seals, walruses, polar bears), caribou, fish, birds (and eggs), furbearers (for hunting and trapping), moose, Dall sheep, grizzly bears, small mammals, and invertebrates, as well as berries, edible roots, and fuel and structural material are extensive. This summary

also includes any new Native stakeholder concerns as they relate to these topics, as well as traditional knowledge updates. Large portions of the marine subsistence-harvest areas of the Alaskan Chukchi subsistence communities are included in the planning area. Kivalina, south of Point Hope, and communities on the Russian Chukchi coast are discussed not because they fall within the Sale 193 Planning Area but because these areas could be contacted by potential oil spills.

The most recent maps for the primary subsistence-harvest areas for Barrow, Wainwright, Point Lay, and Point Hope are located in previous BLM EIS's and on the NSB's web site are shown on locator (see USDO, MMS, 2006a:Appendix C).

III.C.2.c(3) Community Subsistence Profiles.

III.C.2.c(3)(a) Barrow. As with other communities adjacent to the Planning Area, Barrow residents (population 4,199 in 2005 [ADCED, 2006]) enjoy a diverse resource base that includes marine and terrestrial animals. Barrow's location at the demarcation point between the Chukchi and Beaufort seas is unique, offering superb opportunities for hunting a diversity of marine and terrestrial mammals and fishes. Barrow's subsistence-harvest areas are depicted in detail in maps included in MMS' Liberty final EIS (USDO, MMS, 2002) and BLM's Northwest NPR-A final EIS (USDO, BLM and MMS, 2003) and the Alpine draft EIS (USDO, BLM, 2004a). Subsistence resources used by Barrow are listed in tables provided in these same documents. See USDO, BLM and MMS (2003a:Map 75) for bowhead whale-harvest locations near Barrow. No substantial changes to long-term subsistence-harvest practices, subsistence cycles, and types of resources harvested have occurred since MMS' 2003 Beaufort Sea Multiple-Sale final EIS, the 2004 Beaufort Sea Sale 195 EA, the Arctic Ocean Outer Continental Shelf Seismic Surveys—2006 final PEA, and Beaufort Sea Sale 202 EA and the subsequent analyses mentioned above (see also Northern Economics, Inc., 2006). Barrow's annual harvest of bowhead and beluga whales, walrus, and polar bear from the 1980's to 2005 are shown in Tables III.C-4 (bowhead), III.C-5 (beluga), III.C-6 (walrus), and III.C-7 (polar bear).

For BLM's Alpine Satellite Development final EIS (USDO, BLM, 2004b), S.R. Braund and Assocs. conducted eight interviews in August 2003. These interviews were coordinated with the Inupiat Community of the Arctic Slope (ICAS) and included hunters known to travel to the east of Barrow for their subsistence harvests.

The use areas described in these eight interviews generally correlated with previously described subsistence land use areas to the east and southeast of Barrow. Some differences did surface with these hunters not going much farther east of the Itkillik River and many going farther southeast than in the past to the Anaktuvuk River and into areas near the Titaluk and Kigalik rivers, 120 mi south of Barrow. Barrow hunters also described occasionally traveling to the Kalikpik-Kogru River areas for caribou when animals were unavailable closer to Barrow. Winter snowmobile travel for caribou, wolf, wolverine, and fox as far east as Fish and Judy Creeks also was reported (USDO, BLM, 2004b, 2005; USDO, MMS, 2006a,c).

III.C.2.c(3)(b) Atqasuk. Atqasuk, an inland Inupiat community approximately 50 mi south of Barrow, had a population of 247 in 2005 (State of Alaska, Dept. of Community and Economic Development [ADCED], 2006). The marine-resource areas used by Atqasuk residents include those used by Barrow residents as explained in the cited Barrow discussions. Only a small portion of the marine resources used by Atqasuk residents is acquired on coastal hunting trips that are initiated in Atqasuk; most are acquired on coastal hunting trips initiated in Barrow or Wainwright with relatives or friends (ACI, Courtnage, and Braund, 1984). Nevertheless, the local connection with coastal and marine resources is important to the community. As one resident observed, "We use the ocean all the time, even up here; the fish come from the ocean; the whitefish as well as the salmon migrate up here" (ACI, Courtnage, and Braund, 1984). Atqasuk's subsistence-harvest areas are depicted in detail in maps included in the BLM's NW NPR-A final EIS (USDO, BLM and MMS, 2003), and the BLM's Alpine draft EIS (USDO, BLM, 2004a). Subsistence resources used by Atqasuk are listed in tables provided in these same documents. No substantial changes to long-term subsistence-harvest practices, subsistence cycles, and types of resources harvested have occurred since the EIS analyses mentioned above.

For BLM's Alpine final EIS (USDO, BLM, 2004b), S.R. Braund and Assocs. conducted seven interviews of Atqasuk subsistence hunters in August 2003. These interviews were conducted to see if Atqasuk still hunted the drainages of the Kongru and Kalikpik rivers, Fish and Judy creeks, and the Colville River Delta.

Interviews were coordinated with ICAS which identified knowledgeable Atqasuk subsistence users for the interviews.

The use areas described in these seven interviews indicated that the recent Atqasuk use area has expanded over the last decade and extends from the eastern edge of Teshekpuk Lake in the east to the Kaolak River in the west, the Inaru River in the north, and beyond the Colville River in the south. Atqasuk hunters do travel east as far as Fish and Judy creeks. Resources sought in this area by Atqasuk subsistence users include winter fishing in the Ikpikpuk River and lakes west of Teshekpuk Lake and the winter pursuit of wolf and wolverine. Caribou are harvested incidentally. Occasionally, the area of the Kalikpik and Kogru rivers is used by Atqasuk hunters on these same winter snowmobile trips in search of wolf and wolverine. The seven interviews indicated that Atqasuk hunters do not currently hunt in the Nuiqsut or Colville River areas (USDOI, BLM, 2004b, 2005; USDOI, MMS, 2006a,b,c).

III.C.2.c(3)(c) Wainwright. The community of Wainwright, with a population of 520 in 2005 (ADCED, 2006), enjoys a diverse resource base that includes both terrestrial and marine resources. The city sits on the Chukchi Sea coast about 100 mi southwest of Barrow. Marine subsistence activities focus on the coastal waters from Icy Cape in the south to Point Franklin and Peard Bay in the north. The Kuk River lagoon system—a major marine estuary—is an important marine and wildlife habitat used by local hunters. Wainwright is situated near the northeastern end of a long bight that affects sea-ice conditions as well as marine-resource concentrations. Wainwright’s subsistence-harvest areas are depicted in detail in maps included in MMS’ Chukchi Sea Oil and Gas Lease Sale 126 (USDOI, MMS, 1990a) and the BLM’s Northwest NPR-A final EIS (USDOI, BLM and MMS, 2003). No substantial changes to long-term subsistence-harvest practices, subsistence cycles, and types of resources harvested have occurred since the 2003 Northwest NPR-A final IAP/EIS. A summary of Wainwright’s subsistence practices, areas of harvest, and preferred resources appears also in the more recent MMS PEA (USDOI, MMS, 2006a; see also Northern Economics, Inc., 2006). Wainwright’s annual harvest of bowhead and beluga whales, walrus, and polar bear from the 1980’s to 2005 are shown in Tables III.C-4 (bowhead), III.C-5 (beluga), III.C-6 (walrus), and III.C-7 (polar bear).

Lydia Agnasagga in her testimony at a local public hearing in 1987 for MMS’ Chukchi Sea Sale 109 and echoing concerns that still resonate today related:

We live on subsistence, and everybody knows that...especially on the Arctic Coast. We live mainly on the animals from the sea and from the land, as well, and we can’t very well live without those...our food because we didn’t grow up with beef or anything like that, and I can say that everything costs so much nowadays. It’s hard to try to live just by buying...store-bought food, and that’s the reason why I’m concerned about this [lease sale] (USDOI, MMS, 1987c).

At the same hearing, Jim Allen Aveoganna stated:

I was raised [by] hunting only. My dad had never been working, just hunting for a living. And I raised my family half the time just by hunting, which I can say. That’s how we live. Us older people here...we have lived just for [the] hunt. We were raised just by hunting only. No money, nothing. My dad never had been employed; only time he start employ[ment] was the time he was [an] old age citizen. So, that’s how we lived (USDOI, MMS, 1987c).

III.C.2.c(3)(d) Point Lay. With a population of 238 in 2005 (ADCED, 2006), Point Lay has the smallest population of any of the communities in the NSB. About 90 mi southwest of Wainwright, the village sits on the edge of Kasegaluk Lagoon near the confluence of the Kokolik River with Kasegaluk Lagoon. As with other communities adjacent to the Planning Area, Point Lay residents enjoy a diverse resource base that includes both marine and terrestrial animals. However, Point Lay is unique among the communities; its dependence is relatively balanced between marine and terrestrial resources. Unlike the other communities discussed here, local hunters do not pursue the bowhead whale although the community petitioned the Alaska Eskimo Whaling Commission (AEWC) for a bowhead whale quota in 2004 and a community initiative to resume its dormant bowhead hunt is continuing (Associated Press, 2004). Beluga whale is the village’s preferred and pivotal marine mammal resource (Huntington and Mymrin, 1996, Huntington 1999). Barrier island shores, and the protected and productive lagoons they form, provide prime habitat for other sea mammals and birds, both important resources in the Point Lay subsistence round

(USDOI, BLM, 1978a; Fuller and George, 1997). Point Lay's subsistence-harvest areas are depicted in detail in maps included in MMS' Chukchi Sea Sale 126 EIS (USDOI, MMS, 1990a) and the BLM's Northwest NPR-A final IAP/EIS (USDOI, BLM and MMS, 2003). A summary of Point Lay's subsistence practices, areas of harvest, and preferred resources appears also in the more recent MMS Arctic Ocean Outer Continental Shelf Seismic Surveys—2006 Programmatic EA (USDOI, MMS, 2006a; see also Northern Economics, Inc., 2006). No substantial changes to long-term subsistence-harvest practices, subsistence cycles, and types of resources harvested have occurred since the 2003 Northwest NPR-A final IAP/EIS. Point Lay's annual harvest of beluga whales, walrus, and polar bear from the 1980's to 2005 are shown in Tables III.C-5 (beluga), III.C-6 (walrus), and III.C-7 (polar bear).

Gregg Tagarook, hunter and elder from Wainwright, had this to say about weather and hunting conditions in Kasegaluk Lagoon:

I grew up on Barter Island for a long while. I was at Wainwright and lived in Pt. Hope for 14 years. I know a little bit about how things travel, and I've been taught by different community elders, and one elder has said something I never forgot. I'm grateful that I understand a place called Kasegaluk. Our older generation has observed Kasegaluk and said the north wind would blow hard and the current would be strong but this would never change. I understand the hard times and the older generations would take their families out there for camping. When there is nothing dangerous there, I want to say in hunting in fall and mid-winter there would be some shallow spots and the upper part of it would be good. Around there it is dangerous. When the wind is coming from the west, the shore ice would come off from the shore. That is west of Wainwright. A place called Mikigealiak. When it was a west wind, we dared not be out there hunting because it is dangerous. We were saying that the oil industry should know about these conditions that occur when the west wind is blowing in that area because the ice is very strong. North northwest wind. That's that wind 90 miles west of here. (Alaska Traditional Knowledge and Native Foods Database, Northwest Arctic Regional Meeting, Sept. 1998 [UAA, ISER, No date]).

III.C.2.c(3)(e) Point Hope. Point Hope residents, with a population of 702 in 2005 (ADCED, 2006) enjoy a diverse resource base that includes both terrestrial and marine animals. The community, 330 mi southwest of Barrow, is located on a large gravel spit that forms the westernmost extension of the northwest Alaska coast. In the early 1970's, the community moved to its present location just east of the old settlement because of erosion and periodic storm-surge flooding. This spit of land juts out into the Chukchi Sea, offering superb opportunities for hunting a diversity of marine mammals, especially bowhead whales. The combination of caribou, bowhead whale, and fish has been identified as being the primary group of resources harvested; the lowest percentage for this combination occurred in Point Hope, where residents use the greatest variety of subsistence resources, which include beluga whales, walrus, polar bears, birds, marine fish, crab, and berries. Burch (1981) listed 60 species harvest by the village; a NSB subsistence survey in 1992 listed 59 species harvested (Pedersen, 1977; USDOI, MMS, 1987a, 1990a; Fuller and George, 1997; U.S. Army Corps of Engineers, 2005). A discussion of Point Hope's subsistence practices, areas of harvest, and preferred resources appears also in the more recent MMS PEA (USDOI, MMS, 2006a). The primary subsistence-harvest areas for Point Hope are shown in Figures III.C-2 (bowhead whales), III.C-3 (seals), III.C-4 (walrus), and III.C-5 (beluga whales) in this volume. See Tables III.C-8 and III.C-9 for a summary of Point Hope's subsistence harvest resources for 1992.

The Point Hope annual subsistence round is shown in Figure III.C-10. Relative household subsistence consumption, participation, and expenditures on subsistence for Point Hope, as determined from the 1992 NSB subsistence survey and a NSB economic profile and census conducted in 2003 are displayed in Tables III.C-11, III.C-10, and III.C-12, and Figure III.C-7 (Pedersen, 1977; North Slope Borough, 2003; Fuller and George, 1997).

Point Hope's strategic location close to the pack-ice lead makes it uniquely situated for hunting the bowhead. Beginning in late March or early April, the bowhead whale is available in the Point Hope area (see Figs. III.C-1, III.C-6, and III.C-2). Approximately 15-18 whaling camps are located along the edge of the landfast ice. The actual harvest area varies from year to year, depending on where the open leads form. Camps as far south as Cape Thompson have been reported, but in recent years the camps tended to be closer to the community. In the recent past, the camps were situated south and southeast of the point. The

intensive-use area delineated in Figure III.C-2 indicates the harvest-concentration areas over the past few years. The distance of the lead from shore varies from year to year. The lead is rarely more than 6-7 mi offshore, but hunters have had to travel over the ice as far as 10 mi away from the community to find the necessary open water for spring whaling. Table III.C-4 shows the annual bowhead whale subsistence harvest for Point Hope (Pedersen, 1977; ACI and Braund, 1984; USDOJ, MMS, 1990a; Fuller and George, 1997; Woody, 2003).

Point Hope generally has open water for the majority of the whaling season; but sometimes two narrow leads develop. This presents a problem for Point Hope hunters, because the whales may travel in the lead that is farther from shore and, thereby, become inaccessible to the whalers. The duration of the whaling season is limited by the IWC's quota. Despite the limited nature of both the whaling season and the harvest area, no other marine mammal is harvested with the intensity and concentration of effort that is focused on the bowhead whale, the most important resource in Point Hope's subsistence economy. The harvest periods of all resources vary from year to year, and the bowhead season is no exception. In a 20-year period ending in 1982, the total annual number of bowheads landed varied from 0-14. In the recent memory of community residents, 1980 and 1989 were the only years in which a bowhead whale was not harvested. The last subsistence survey in the village was conducted by the NSB in 1992 and noted that two bowheads were landed that year—a poor harvest year (6.9% of the total subsistence harvest) due to onshore winds creating poor ice conditions (Pedersen, 1977; ACI and Braund, 1984; USDOJ, MMS, 1990a; Fuller and George, 1997).

Point Hope hunters actively harvest the beluga whale during the offshore spring bowhead-whaling season (late March-early June) and along the coast later in summer (July-late August/early September) (Fig. III.C-5). The first, also the larger, harvest of belugas occurs coincidentally with the spring bowhead whale harvest, and hunters often use the beluga as an indicator for the bowhead. Although not as common as the bowhead, the beluga also is harvested in open water throughout the summer. During the summer season, hunters pursue belugas primarily near the southern shore of Point Hope in the southern Chukchi Sea, in close proximity to the beach, as well as in coastal areas on the northern shore as far north as Cape Dyer. Because belugas feed on the anadromous fishes of the Kukpuk River, hunters are particularly successful near Sinuk. The beluga is harvested intensively at distances as far south as Cape Thompson (Fig. III.C-5). Although belugas are available in May and June, Point Hope residents generally do not pursue them because of deteriorating ice conditions along the landfast ice margins and the greater availability of bearded seal and walrus at this time (Pedersen, 1977; USDOJ, MMS, 1990a; Fuller and George, 1997).

The number of belugas harvested varies (Table III.C-5); according to Lowenstein (1981), each whaling crew harvests at least one beluga—and usually more—during the whaling season. The average annual beluga harvest (between 1962 and 1982) was estimated at 29, or 6.5% of the total annual marine-subsistence harvest. The 1992 NSB subsistence survey estimated a beluga harvest of 98 animals—40.3% of the total subsistence harvest (Pedersen, 1977; USDOJ, MMS, 1990a; Fuller and George, 1997).

Point Hope Inupiat have traditionally used walrus; however, the increasing importance of the walrus as a subsistence resource has been directly related to its fluctuating population. Walruses are harvested during the spring marine mammal hunt, which is based along the southern shore of the point (Fig. III.C-4). The major walrus hunting effort coincides with the spring bearded seal harvest, and both species are harvested from the same camps that stretch from Point Hope to Akoviknak Lagoon. Although the walrus is hunted primarily during late May and early June, it also is hunted by boat during the rest of the summer along the northern shore, especially along the rocky capes and other points where they tend to haul out. The walrus harvest occurs in conjunction with other subsistence activities such as egg gathering, fishing, or traveling the shores in search of caribou. An estimated 10-30 animals are harvested during June (ACI, Courtneage, and Braund, 1984). The annual average harvest (from 1962-1982) was estimated at 15 walruses, or 2.9% of the total annual marine mammal subsistence harvest. Walrus harvest totals in Point Hope from 1982 through 2005, derived from the USDOJ, Fish and Wildlife Service (FWS) Marking, Tagging, and Reporting Program (MTRP) are shown in Table III.C-6. Reported MTRP numbers are generally lower than actual harvests. The 1992 NSB subsistence survey estimated a walrus harvest of 72 animals—16.4% of the total subsistence harvest (Pedersen, 1977; USDOJ, MMS, 1990a; Fuller and George, 1997; Garlich-Miller, 2006, pers. commun.).

Point Hope residents hunt polar bears primarily from January to April concurrently with the winter seal hunting season, and occasionally from late October to January. The polar bear is harvested mainly south of the community, generally in the area of intensive seal hunting (ACI, Courtnage, and Braund, 1984). The polar bear comprises a small portion of the Point Hope subsistence harvest with an annual average (from 1962-1982) of nine harvested, or only 1.1% of the total annual marine mammal subsistence harvest. The 1992 NSB subsistence survey showed that no polar bears were harvested that season but FWS data indicate 9 harvested during the 1991/92 season and 17 harvested during the 1992/93 season (Table III.C-7) (Pedersen, 1977; USDOJ, MMS, 1990a; Fuller and George, 1997; Schliebe, 2006, pers. commun.).

Seals are available to Point Hope residents from October through June; however, because of the availability of bowhead, bearded seal, and caribou during various times of the year, seals are harvested primarily during the winter months, from November through March. The ringed seal is the most common hair seal species harvested, and the month of February is the most concentrated harvest period for this species. Hair seals are hunted from south of Cape Thompson to as far north as Ayugatak Lagoon (Fig. III.C-3). The area south of Point Hope is safer and more advantageous for hunting seals. In good weather, it is safe for a hunter to travel 10-15 mi offshore of the southern side of the point; however, it is more common for residents to hunt seals closer to shore. The area north of the point is more dangerous for seal hunting because of the poor ice conditions. Seal hunting in this area occurs closer to shore and is most successful at Sinuk, near the mouth of the Kukpuk River, and at the numerous small points between Point Hope and Cape Lisburne, where open water is found (i.e., Kilkralik Point and Cape Dyer). South of the point, ringed seal hunting generally is concentrated within 5 mi of shore on the ice pack between Point Hope and Akoviknak Lagoon. Some hair seal hunting takes place directly off the point when the ice first forms in October and early November. From 1962-1982, the average annual harvest was estimated at 1,400 seals, or 14.8% of the total annual subsistence harvest. The 1992 NSB subsistence survey estimated that 265 ringed and 50 spotted seals were harvested that season (Pedersen, 1977; ACI, Courtnage, and Braund, 1984; Fuller and George, 1997).

Hunting of the bearded seal is an important subsistence activity in Point Hope; the meat is a preferred food and the skin is used to cover whaling boats. Most bearded seals are harvested during May and June, sometimes as late as mid-July, as the landfast ice breaks up into floes. More bearded seal than the smaller hair seal is harvested because of the former's larger size and use for skin-boat covers. Bearded seals, like hair seals, are hunted from Cape Thompson to Ayugatak Lagoon. The average annual fur seal harvest from 1962-1982 was 200 a year, or about 8.9% of the total annual subsistence harvest (ACI, Courtnage, and Braund, 1984; USDOJ, MMS, 1990a). The 1992 NSB subsistence survey showed that 160 bearded seals were harvested that season—8.3% of the total subsistence harvest (Table III.C-9) (Pedersen, 1977; Fuller and George, 1997).

Caribou is the primary source of meat for Point Hope residents. From 1962-1982 the annual average of 756 caribou harvested accounted for 29.5% of the total annual subsistence harvest (ACI, Courtnage, Braund, 1984). Although caribou are available throughout the year, peak harvest times occur from February-March and from late June through mid-November. The 1992 NSB subsistence survey showed that 225 caribou were harvested that season—7.7% of the total subsistence harvest (Table III.C-9; Pedersen, 1977; USDOJ, MMS, 1990a; Fuller and George, 1997).

Point Hope residents harvest a variety of fish during the entire year. As the shorefast ice breaks free in mid- to late June, residents use setnets and beach seines to catch arctic char and pink, coho, and chum salmon. Fishing occurs from coastal fish camps (often converted from spring camps for hunting bearded seal and walrus) located along the shore from Cape Thompson north to Kilkralik Point. Some fishing may occur outside this area, but only in conjunction with other activities such as egg gathering or caribou hunting. The summer fishing season extends from mid- to late June through the end of August, with July the peak month. Other fishes harvested by Point Hope residents include whitefish, grayling, tomcod, and occasionally flounder. In the fall, residents harvest grayling and whitefish on the Kukpuk River during the October upriver fishing period. From December through February, residents fish for tomcod through the ice near the point (ACI, Courtnage, and Braund, 1984). From 1962-1982, an estimated annual average of 40,084 lb was harvested, accounting for 10.1% of the total subsistence harvest. The 1992 NSB subsistence survey showed that 30,589 lb of fish were harvested that season—9.0% of the total subsistence harvest (Table III.C-8) (Pedersen, 1977; ACI, Courtnage, and Braund, 1984; USDOJ, MMS, 1990a; Fuller and George, 1997).

Throughout the year, waterfowl and other migratory birds also provide a source of food for Point Hope residents. Eiders and other ducks, murre, brant, geese, and snowy owls are harvested at various times of the year. Eiders are harvested as they fly along the open leads during the whaling season and provide a fresh meat source for the whaling camps. Murre eggs are harvested from the cliffs at Capes Thompson and Lisburne. Later in the spring, Point Hope residents harvest eiders, geese, brant, and other migratory waterfowl along both the northern and southern shores of the point and in the numerous lakes and lagoons. Geese are harvested from mid-May until mid-June, while brant are harvested at this time and during September, as they migrate south from their summer breeding grounds. Snowy owls occasionally are trapped later in the fall, in October, as they migrate south. From 1962-1982, an estimated annual average of 12,527 lb of birds was harvested, accounting for about 3.2% of the total annual subsistence harvest. The 1992 NSB subsistence survey showed that 9,429 lb of birds was harvested that season—2.8% of the total subsistence harvest (Table III.C-8) (Pedersen, 1977; ACI, Courtnage, and Braund, 1984; USDOI, MMS, 1990a; Fuller and George, 1997).

III.C.2.c(3)(f) Kivalina. Kivalina residents, with a population of 317 in 1990, 377 in 2000, and 385 in 2005 (USDOC, Bureau of the Census, 1991, 2001; ADCED, 2006), enjoy a diverse resource base that includes both terrestrial and marine animals. The community is 95 mi northwest of Kotzebue on the southeastern tip of an 8-mi-long barrier island between Kivalina Lagoon and the Chukchi Sea. Unlike all of the previous villages discussed, which fall within the boundaries of the North Slope Borough, Kivalina is within the boundaries of the Northwest Arctic Borough. Kivalina is isolated on a barrier island. The community is also threatened by shoreline erosion and storm surge (Besse, 1983; ADCED, 2006).

Most of the people in Kivalina depend heavily on subsistence practices for food. Beluga and bowhead whales, walrus, bearded and ringed seals, polar bear, caribou, moose, Dall sheep, fish (char, cod, salmon, and whitefish), and birds (geese, ducks and ptarmigan) are particularly important in the subsistence diet. Tables III.C-13a-e show important subsistence resources historically harvested in Kivalina. Bearded seal, ringed seal, and beluga whale are consistently important among the marine mammals harvested. Caribou is the most important land animal, and char (Dolly Varden “trout”) the most important fish harvested. Waterfowl and ptarmigan are the most important birds harvested. Long-term trends can be seen in the harvest of ringed seals by the steady decline between 1964 and 1992, and by the increase in the numbers of moose harvested. The importance of subsistence foods to Kivalina households can be seen in Table III.C-14. People from Point Hope, Kotzebue and vicinity, and Noatak also report utilizing the same area (Burch 1985; U.S. Army Corps of Engineers, 2005).

Beluga Whales. A spring and a summer stock of beluga whales are harvested by Kivalina subsistence hunters (see Fig. III-C-8). The spring hunt can start as early as March when offshore leads are present and ice conditions permit it. Early belugas are from the Beaufort Sea stock that winters in the Bering Sea and summers in the Mackenzie River delta; they migrate through leads running parallel to the shoreline that recur in most years from one to several miles offshore of Kivalina beginning in late March and April; hunting takes place generally from late April through May, often coinciding with the hunt for bowhead whales. In some years, more than one parallel lead forms, while in other years, leads do not form at all, or form only sporadically through the whaling season. Because of these variable ice conditions, successful hunting for spring beluga is dependant on prevailing ice conditions during the migration. In some years westerly winds close accessible leads, and in other years more than one offshore lead forms, allowing belugas to move through leads farther offshore and escape subsistence hunters (Burch 1985; U.S. Army Corps of Engineers, 2005).

The best spring hunting conditions for Kivalina occur when a single and accessible lead forms offshore Kivalina and ends just north of the community. Under these conditions, belugas are concentrated in an area accessible to local hunters. Another ideal situation for hunting beluga occurs when a lead in which the belugas have been migrating closes, and they become trapped in a small patch of open water (Braund, 1999). The 2002 whaling season near Kivalina was characterized by unstable, “growling,” ice in which the leads formed too far offshore (R. Adams Sr., U.S. Army Corps of Engineers, 2005). Spring belugas are shot with rifles; then the carcass is snagged with a seal hook to keep it from sinking. Belugas are pulled onto the ice or taken ashore for butchering and distribution. Snow machines are used for transportation during the hunt and tow large sleds that hold boats and materials for hunting base camps that are sometimes set up on the ice (U.S. Army Corps of Engineers, 2005).

Summer belugas occur in late June and July after breakup. This beluga stock is part of the eastern Chukchi Sea/Eschsoltz Bay stock that migrates north past Kivalina to the Point Lay vicinity. In the past, this stock migrated close to shore after breakup. Belugas from the summer stock are hunted from outboard powered boats. They are shot and snagged with seal hooks or harpooned to prevent them from sinking into turbid coastal waters and then towed ashore for butchering (U.S. Army Corps of Engineers, 2005).

Figure III-C-8 shows subsistence hunting areas and the migration path for the summer stock of belugas near Kivalina, as described by Kivalina hunters. According to Native hunters, before the construction of the port site for the Red Dog Mine, the hunt for summer belugas historically took place along a relatively short stretch of coast south of Kivalina, but today the summer beluga hunt extends along a much longer section of coast from Kotlik Lagoon to Cape Thompson (U.S. Army Corps of Engineers, 2005).

Ice conditions can disrupt or even prevent the summer hunt even though it takes place after breakup. Westerly winds can blow offshore pack ice inshore and pile it on the beaches. These conditions can block the entrance to Kivalina Lagoon (Singauk Entrance), preventing boats from reaching open water. On the other hand, if belugas are detained near shore by piled ice, boats have an easier time reaching the trapped whales (U.S. Army Corps of Engineers, 2005).

Table III.C-5 presents beluga harvest data since 1980 from Barrow, Wainwright, Point Lay, Point Hope and Kivalina. Since 1986, when beluga counts were separated into spring and summer stocks, Kivalina hunters have taken more spring beluga than all the other communities, except Point Hope, which is located on the migratory pathway of spring beluga. Kivalina hunters have taken considerably fewer summer beluga than most of the other communities, and there has been a general decline in the harvest of belugas in northwestern Alaska in the same period, except by communities more closely situated along the migratory path of the summer (eastern Chukchi Sea) stock such as Point Lay and Wainwright which are near summer gathering areas on the northern end of the summer beluga range (see also Table III.C-13a). A 1992 ADF&G subsistence survey conducted in the community indicated a harvest of 10 belugas—3.8% of the total subsistence harvest (U.S. Army Corps of Engineers, 2005; ADF&G, 2006).

In addition to spring and summer harvests, belugas have sometimes been taken near Kivalina during August and the fall. Belugas harvested during the fall are likely early inshore migrants of the eastern Chukchi Sea/Eschsoltz Bay stock heading south. The fall migration route of the Beaufort Sea stock moves across the Chukchi Sea and down the Russian coast, and they are not harvested by Alaska Chukchi communities (Burch 1985; U.S. Army Corps of Engineers, 2005).

Bowhead Whale. Kivalina is too far east of the main bowhead whale spring migration path to intercept them in any great numbers, but bowheads do occasionally follow the nearshore leads that run past Kivalina. In the distant past, Kivalina hunters maintained a spring whaling camp at Nuvua, a projection of land about 27 mi northwest of Kivalina where the lead was closest to land. This practice was discontinued in the 1880's when Kivalina hunters chose to hunt bowheads from Point Hope, a practice that lasted up to the 1960's. Around 1966, the Kivalina bowhead hunt resumed from the ice offshore of the village. The community took its first whale in 1968; three more were taken between 1968 and 1982 and three others were struck and lost during this same period (Burch 1985; U.S. Army Corps of Engineers, 2005).

Kivalina hunters begin watching for bowheads in the leads north and south of Kivalina in late April (see Fig. III.C-9). Ice conditions are critical for a successful hunt, and bad ice conditions can prevent the hunt in some years. Bowheads and early spring belugas can travel together and similar ice conditions can affect both hunts. Similar to the beluga hunt, snow machines are used to pull sleds that haul boats and materials to hunting camps that can be set up on the ice. Bowhead whales are harpooned with a harpoon bomb and then with a harpoon attached to a float. The bowhead is towed by boat to a place where the ice can support the carcass; it is pulled onto the ice with block and tackle—an effort that takes the cooperation and effort of the whole community—where it is butchered and distributed (Burch 1985; U.S. Army Corps of Engineers, 2005).

The AEWG has authorized Kivalina four bowhead strikes annually, but it is uncommon for the community to take a whale (see Tables III.C-4 and III.C-13a). Between 1991 and 2002, Kivalina harvested five bowheads. Strike quotas can be transferred from one community to another and, in years when bad ice

conditions prevent whaling near Kivalina, the village has transferred its quota to Point Hope; the sharing of whale meat between these two communities has continued since the 1880's. A 1992 ADF&G subsistence survey conducted in the community indicated a harvest of 1 bowhead whale—5.1% of the total subsistence harvest (Burch 1985; U.S. Army Corps of Engineers, 2005; ADF&G, 2006).

Walrus. Walrus typically are hunted in June or early July when they follow the receding polar pack ice edge as it moves north. Walrus are not typically plentiful in the Kivalina area compared with the central and western Chukchi Sea (see Fig. III.C-10). According to Burch (1985), walrus appear in higher numbers near Kivalina once or twice every 20 years or so, when floes bring them close to shore. However, hunters from Kotzebue and Kivalina report walrus near Kivalina more often than this (Georgette and Loon 1993; Burch 1985). It is not uncommon for subsistence hunters in the region to travel long distances to hunt walrus, and hunters from Kivalina and nearby coastal communities can travel as far as 30-40 mi offshore to harvest them (see Table III.C-12). Some hunters from farther south in the Bering Strait region have reported traveling up to 300 mi to hunt walrus. Hunters typically approach herds rafted on icefloes and shoot them on the ice with rifles. Dead walrus pushed or pulled into the water by other walrus generally sink, but can be recovered with a seal hook (Burch 1985; U.S. Army Corps of Engineers, 2005).

Kivalina hunters harvested 62 walrus from 1959 through 1984 and 128 walrus from 1988 through 2000 (since construction of the port site for the Red Dog Mine). The larger harvest in recent years probably is a factor of faster boats and greater hunting effort. A 1992 ADF&G subsistence survey conducted in the community indicated a harvest of 27 walrus—8.1% of the total subsistence harvest (see Tables III.C-12 and III.C-13a; ADF&G, 2006; U.S. Army Corps of Engineers, 2005).

Seals. Ice conditions determine the level of effort required to hunt seals and often determine the success of the hunt. The thickness of shore-fast ice can affect the distribution of ringed and bearded seals and affect the safety of hunters traveling on the ice. Thin ice produces leads and cracks where seals congregate, but in the leads, thinner ice also piles into pressure ridges that make travel difficult and dangerous for hunters. Snow depth on shorefast ice can influence the seal harvest: deeper snow makes snowmachine travel easier, but deep snow can also help hide female ringed seals in their lairs (Burch 1985; U.S. Army Corps of Engineers, 2005).

Hunting for seals can begin as early as January or February, but usually is not active until March or April, when ice and weather conditions are generally better; seal hunting typically peaks in June. Warmer weather brings seals out onto the ice to bask in the sun, where they are more vulnerable to hunters, but these weather conditions also cause melt water to pool on the ice and make hunter access more difficult. Seals typically are hunted from boats from April to June when leads form in the ice. In the open leads, wind can be a determining factor in a successful seal hunt. Easterly winds can drive ice offshore, taking seals with it; westerly winds can pile ice against the shore and prevent boat travel. When prevailing winds are light, variable, and oppose ocean currents, open leads are created—ideal hunting conditions that allow hunters to reach the seals by boat. Kivalina's subsistence-harvest area for seals is shown in Figure III.C-11 (Burch 1985; U.S. Army Corps of Engineers, 2005).

Spotted Seal. Spotted seals are not as abundant or as heavily hunted in the Kivalina area as in other parts of the region. Spotted seals are larger than ringed seals and are harvested along leads in the ice or along the receding icepack edge. Hunters believe that spotted seals are particularly aware of unusual or sudden movements. Such movements can frighten the seals into diving (Nelson 1969). In the kayak or boat "it is important to present an unchanging profile to the seal. With an outboard motor, one should maintain the speed of the engine, since it is a change that will alert the animal (Huntington and Mymrin 1996)." In traditional knowledge of the region, spotted seals are one of three sea mammals considered dangerous because they will sometimes intentionally attack humans (see Table III.C-13a; Nelson 1969; Burch 1985; U.S. Army Corps of Engineers, 2005).

Ringed Seal. Ringed seals are widely distributed and local subsistence hunters generally consider them easier to harvest than other seals. As a result, they are less frequently talked about than other marine mammals that are more valued. A common theme in oral accounts is that ringed seals are still an important subsistence resource in the region; in earlier times, they were a mainstay in the human diet and an important food source for sled dogs. In the past, ringed seals were very important to the local subsistence economy and were harvested in higher numbers than any other resource until the 1990's when the harvest

numbers of bearded seals overtook them. With fewer dog teams and the coming of the snow machine, ringed seals have lost importance as a subsistence resource. However, they still retain a high cultural importance in the region and are extensively used for subsistence camp meat during long stays while hunting on the ice. A 1992 ADF&G subsistence survey conducted in the community indicated a harvest of 110 ringed seals—2.9% of the total subsistence harvest (see Table III.C.13-a; Burch 1985; Braund 1999; Runyan, 2001; U.S. Army Corps of Engineers, 2005; ADF&G, 2006).

Ringed seals are stalked and shot with rifles while they are basking on the shorefast ice or drifting floes. They also are shot in the water and recovered with a grappling hook known to local hunters as a seal hook. Ringed seals may be hunted as soon as the ice forms in November or December, but most of the hunting and harvest of ringed seals now takes place between February and late June, when the seals concentrate on the ice near cracks and leads or on floes. Ringed seals are mostly taken on shorefast ice, but sometimes they are hunted on pack ice March through May in conjunction with hunts for bearded seals and beluga whales (Burch 1985; U.S. Army Corps of Engineers, 2005).

Because basking ringed seals are easily frightened, they were traditionally hunted at breathing holes, where hunters made considerable efforts to avoid being seen or heard. A hunter might stand on ice blocks or a stool so the seals could not see his shadow through the ice. Dogs were tied more than 100 yards away so their noise did not scare the seals. By contrast, in the open water ringed seals are known to become very curious about unusual noises and to be drawn to them. Hunters attract the seals by making noises at open leads by “chopping the ice with an *unaak*, making a raspy ‘Donald Duck’ sound in the throat, beating the side of a sled or skin boat with a stick, operating a camp stove, whistling, humming, stamping or scraping the ice with one’s boot, driving a dog team along the ice apron, or just talking loudly” (Nelson 1969; Burch 1985; U.S. Army Corps of Engineers, 2005).

Bearded Seal. Bearded seals were historically harvested in fewer numbers than ringed seals, but the bearded seal harvest has now eclipsed the ringed seal harvest (see Table III.C-13a). Adult bearded seals are at least five times heavier than adult ringed seals and make a greater dietary contribution. The change in harvest emphasis may have occurred due to the switch from dog teams to snowmachines, thus reducing the need to harvest large ringed seals for dog food. Modern goods have replaced items crafted from ringed seals, and ringed seal skins have plummeted in value. Today, bearded seals have become a more preferred source for food and oil and have a greater value in trading and sharing. A 1992 ADF&G subsistence survey conducted in the community indicated a harvest of 269 bearded seals—20.6% of the total subsistence harvest (Burch 1985; ADF&G, 2006; U.S. Army Corps of Engineers, 2005).

From November through August, bearded seals are hunted from shorefast and pack ice near Kivalina. The customary Kivalina hunting area for bearded seals is shown in Figure III.C-11 (Braund, 1999, 2000). Bearded seals in the Kivalina area are typically stalked and shot with rifles when their numbers peak in June and when large numbers are basking along leads and on floes. Most of the harvest takes place in spring, because bearded seals mostly inhabit thin or broken pack ice, making them difficult or dangerous to reach the rest of the year. Bearded seals shot in the water generally are recovered using a seal hook. Bearded seals vary in their alertness and wariness, depending on the time of year, and are relatively tolerant of aircraft and boats. Some hunters say that bearded seals never haul out very far from a lead or crack in the ice, so they can quickly return to the water. However, once in the water, they are known to swim up to hunters out of curiosity (Nelson, 1969; Burns and Frost, 1979; Burch, 1985; U.S. Army Corps of Engineers, 2005).

Bearded seal is the principal species used for providing seal oil. Seal oil has many traditional uses, including use as a preservative for other subsistence foods and as a condiment. Traditionally, seal oil is also valued medicinally for curing frostbite, colds, and other ailments; it also has spiritual value in Iñupiaq culture for promoting a feeling of “well being” and a connection to the culture when eaten. Historically, seal oil was traded with inland communities that did not have access to coastal hunting areas. A traditional food known as “dark meat,” is made from dried bearded seal meat, and the fermented flipper also is a traditional food. Almost every part of all seal species had traditional uses (Burch, 1985; U.S. Army Corps of Engineers, 2005).

Polar Bear. During hunts for other species, such as beluga and bowhead whales, polar bears are often seen and killed. Alaskan Natives are the only hunters authorized by the Marine Mammal Protection Act to take them in the United States. Because polar bears are attracted by noise and may follow the sound to its

source, they are most often killed at hunting sites where seals or beluga whales are being butchered on the ice and also near communities where they may be a threat to people and property. Polar bear flesh is still eaten, but it can be infected with the parasite trichina and must be thoroughly cooked. Because of its high vitamin A content, polar bear liver is poisonous (Burch, 1985; Napageak, 1996; U.S. Army Corps of Engineers, 2005).

Comparatively few polar bears are killed by Kivalina subsistence hunters (see Tables III.C-13a and III.C-7). The number of polar bears reported killed from 1987 through the winter of 2001/2002 was 25 animals. Native hunters in the Bering Strait/Saint Lawrence Island area (526 animals), Barrow (262 animals), and Point Hope (161 animals) took much higher numbers of polar bears for the same period. Harvest levels from the Chukchi Sea stock from 1996 through 2000 have been declining, with the mean harvest at about 49 bears per year. A 1992 ADF&G subsistence survey conducted in the community indicated a harvest of 8 polar bears—0.3% of the total subsistence harvest (USDOI, FWS, 2001, 2002; ADF&G, 2006; U.S. Army Corps of Engineers, 2005).

Caribou. Caribou are hunted in the tundra hills behind Kivalina and provide the principal terrestrial subsistence animal for the community and the region (see Table III.C-13b). Local caribou are part of the Western Arctic Herd that migrates annually in large numbers through the region. Most caribou are harvested in the fall when the main migration reaches the Kivalina area, but they are also hunted throughout the winter, as available, and shot opportunistically year-round. Caribou are hunted from snowmachines when there is enough snow on the tundra for them to operate and sometimes from four-wheelers along the Red Dog Mine road when there is no snow. Boating local rivers is another means to reach hunting areas in the fall before freezeup. Caribou are shot with rifles and brought home or they can be temporarily cached on the tundra, if the weather is cold enough to keep the meat from spoiling. Small planes or boats startling leaders of caribou herds have been reported by residents of Noatak, and this can divert the herd from moving south along the coast near Kivalina and shift them inland and make them move toward Noatak (Uhl and Uhl, 1977; Burch, 1985; U.S. Army Corps of Engineers, 2005).

The number of caribou needed to support an average Kivalina family is estimated at up to 12 animals; in former days, when local families had dog teams, up to 40 caribou per family were needed. A 1992 ADF&G subsistence survey conducted in the community indicated a harvest of 351 caribou—18.2% of the total subsistence harvest (ADF&G, 2006; U.S. Army Corps of Engineers, 2005).

Moose. Moose are relative newcomers to the region. The first moose harvested near Kivalina was taken in the 1950's (see Table III.C-13b). Moose are hunted with rifles during the fall and winter when they congregate along the riverbanks and become more easily accessible to hunters on snowmachines. At other times, moose generally scatter across the tundra and move to higher elevations where they are not as easily reached by subsistence hunters; they are also more difficult to process in the field because of their large size and weight. Caribou are preferred over moose, because moose meat is said to be dry and tough compared with caribou. A 1992 ADF&G subsistence survey conducted in the community indicated a harvest of 17 moose—3.5% of the total subsistence harvest (Burch, 1985; ADF&G, 2006; U.S. Army Corps of Engineers, 2005).

Dall Sheep. Dall sheep are hunted in the Delong and Baird mountains north and east of Kivalina; they are prized for their meat, fat, sinew, skins, and horns (see Table III.C-13b). Traditionally, Dall sheep were hunted in the summer, but modern conservation laws restrict modern hunts to the winter season. The upper Wulik and Kivalina River drainages are preferred Dall sheep hunting areas. People traveled traditionally by foot or dog team to the upper drainages to hunt sheep, but the modern hunt is done by snowmachine in winter. Dall sheep also were known to be taken on egg-gathering trips to Cape Thompson. Current regulations allow one sheep to be taken on a per-permit basis when Federal and State biologists determine a surplus of rams is available. Kivalina hunters are more culturally tied to caribou and harvest relatively few Dall sheep. Kivalina hunters reported taking about 25 Dall sheep in the 25 years prior to 1991. A 1992 Alaska Department of Fish and Game subsistence survey conducted in the community indicated no Dall sheep harvested (Burch, 1985; Georgette and Loon, 1991; U.S. Army Corps of Engineers, 2005).

Fish. The most important subsistence-fish species in Kivalina are Dolly Varden char, grayling, whitefish, burbot, and several species of Pacific salmon (see Table III.C-13c). In terms of poundage, char, whitefish, and salmon are the most successfully harvested, largely because they are caught with nets and seines.

Saffron cod and smelt occasionally are harvested, and large numbers of cod can be caught with hook and line when they migrate into Kivalina Lagoon. Burbot, a bottom-dwelling species, is caught only occasionally. A 1992 ADF&G subsistence survey conducted in the community indicated a harvest of 87,068 lbs of fish—33.3% of the total subsistence harvest (Burch, 1985; ADF&G, 2006; U.S. Army Corps of Engineers, 2005).

Char. Dolly Varden char are caught year round, with peak harvests in June when the fish are going to sea, and in September after they return to the larger rivers to overwinter. Spring char are primarily caught in gill nets set in Kivalina Lagoon and along the spit south of the community. Sea ice jams in the lagoon outlet sometimes trap char in the lagoon for long periods leading to large numbers being harvested (Burch, 1985; U.S. Army Corps of Engineers, 2005).

The fall harvest is determined by run size, the onset of freezeup, and scavenging animals. The fall run is caught at traditional sites along the Wulik River and then buried in caches at fish camps. After freezeup, dropping water levels in the river and falling temperatures make access to fishing areas by boat more difficult and traditional methods for preservation in the caches along the riverbank more problematic. Scavenging grizzly bears and wolverines can dig up the caches and, if fishers have to bring the fish to Kivalina to avoid scavengers, smaller catches and shorter fishing excursions result (U.S. Army Corps of Engineers, 2005).

Arctic grayling. Grayling is a freshwater species that is also found in brackish lagoons. Kivalina fishers catch them in the Wulik River drainage and Kivalina Lagoon. Considerable effort is spent fishing for them through the ice during the winter with hook and line. Grayling are also caught while netting and seining for char and whitefish (Burch, 1985; U.S. Army Corps of Engineers, 2005).

Pacific salmon. Summer-run salmon enter Kivalina Lagoon and other rivers of the region starting in June with Chinook and are followed by chum and coho through August and September. Gillnets set to harvest char in freshwater and estuaries also net salmon; some are caught in seines and with hook and line. Kivalina fishermen harvest a large amount of salmon species (see Table III.C-13c; Burch, 1985; U.S. Army Corps of Engineers, 2005).

Whitefish. Both anadromous and migratory species of whitefish are caught in the fresh waters in the Kivalina area. The whitefish harvest generally peaks in the fall when the fish are running upriver to spawn. The greatest numbers of whitefish are caught in Kivalina Lagoon and the lower Wulik and Kivalina River drainages by fishers using seines and gillnets; huge numbers are sometimes taken (see Table III.C-13c). Fall-caught whitefish are preserved in caches, frozen or dried, and dipped in seal oil when eaten (Burch, 1985; U.S. Army Corps of Engineers, 2005).

Cod. Saffron cod can enter Kivalina Lagoon in huge numbers and are caught by jigging with hook and line through holes in the ice (Table III.C-13c). Temperatures are typically low when cod are present in the lagoon, and they are frozen on the ice where they are caught (Burch, 1985; U.S. Army Corps of Engineers, 2005).

Birds. Ducks, geese, and less-often swans, are the primary subsistence species hunted by coastal subsistence hunters in the Kivalina region (Table III.C-13d). Both birds and their eggs are harvested. Waterfowl hunting generally occurs in the spring when birds are migrating northward to nesting grounds farther north. Locally nesting waterfowl also is harvested. Regional hunters tend to prefer geese, especially black brant, over ducks. Under northerly wind conditions, northward migrating geese fly low over local beaches and are taken with shotguns as they head inland from the beach. Geese also are taken from tundra ponds with rifles and shotguns. Eggs are collected from nests on the tundra and around ponds and lagoons. Ptarmigan are traditionally hunted by the younger boys with shotguns in the fall, winter, and early spring. Traditionally, snowy owls were taken, but few are taken today. They were taken in leg-hold traps or snares when they landed. Birds taken for subsistence are preserved using traditional methods, frozen in home freezers, or cooked and eaten fresh. A 1992 ADF&G subsistence survey conducted in the community indicated a harvest of 3,708 lbs of birds—1.4% of the total subsistence harvest (Minn, 1982; Braund and Berman, 1983; Burch, 1985; USDO, FWS, 2001, 2002; U.S. Army Corps of Engineers, 2005; ADF&G, 2006).

III.C.2.c(3)(g) Kotzebue and Kotzebue Vicinity Communities. Although outside of the Sale 193 Planning Area, the community of Kotzebue and the more inland subsistence communities of Noatak, Noorvik, Kiana, Ambler, Shungnak, Kobuk, Selawik, Buckland, and Deering are discussed briefly, because the oil-spill-risk analysis for Sale 193 included the coastline as far south as the Bring Strait in its risk simulations. Also, these communities harvest marine and terrestrial mammals and waterfowl extensively in Kotzebue Sound and along and nearshore the Chukchi coast as far north as Point Hope. Potentially, important coastal and nearshore subsistence harvest areas could be contacted in the event of a large oil spill.

The City of Kotzebue lies at the northern end of the Baldwin Peninsula in Kotzebue Sound. With 3,082 residents in 2000, and 3,120 in 2005 (USDOC, Bureau of the Census, 2001; ADCED, 2006), the community has a mixed cash and subsistence economy and is the regional supply and transportation hub for the Northwest Arctic Borough and surrounding smaller communities. At the intersection of three river drainages—the Noatak, the Kobuk, and the Selawik rivers—Kotzebue's location makes it the transfer point between ocean and inland shipping for the region. Government and the Red Dog Mine are the biggest employers, and commercial fishing and processing provide seasonal employment. Subsistence is the predominant local and regional lifeway. Marine mammals (beluga whales, seals, walrus); fish (salmon and whitefish); caribou; moose; and waterfowl are the main subsistence resources harvested in the region (Besse, 1983; Schroeder, Andersen, and Hildreth, 1987; Schroeder et al., 1987; ADCED, 2006; see Table III.C-14).

Noatak is located on the west bank of the Noatak River, 55 miles north of Kotzebue. This Inupiat village had 428 residents in 2000 and 473 in 2005 (USDOC, Bureau of the Census, 2001; ADCED, 2006). Subsistence activities are the central focus of the community. In the summer, families travel to seasonal fish camps at Sheshalik, on the north shore of Kotzebue Sound. Marine mammals, chum salmon, whitefish, caribou, moose and waterfowl are important subsistence resources. Seven residents hold commercial fishing permits (Foote, 1959; Besse, 1983; Braund and Berman, 1983; Schroeder, Andersen, and Hildreth, 1987; Schroeder et al., 1987; ADCED, 2006).

Noorvik is located on the Nazuruk Channel of the Kobuk River, 45 mi east of Kotzebue. In 2000, the community had 634 residents and 628 in 2005 (USDOC, Bureau of the Census, 2001; ADCED, 2006). Its Inupiat residents are heavily dependent on subsistence harvests of marine mammals, caribou, fish, moose, waterfowl, and berries (Besse, 1983; Schroeder, Andersen, and Hildreth, 1987; Schroeder et al., 1987; ADCED, 2006).

Kiana is located on the north bank of the Kobuk River, 57 mi east of Kotzebue. This Inupiat village had 388 residents in 2000 and 380 in 2005 (USDOC, Bureau of the Census, 2001; ADCED, 2006). Kiana residents practice a subsistence lifestyle, and the village economy depends on traditional subsistence harvests of chum salmon, freshwater fish, moose, caribou, and waterfowl (Besse, 1983; Schroeder, Andersen, and Hildreth, 1987; Schroeder et al., 1987; ADCED, 2006).

Ambler is 138 mi northeast of Kotzebue and sits on the north bank of the Kobuk River near its confluence with the Ambler River. The community had 309 residents in 2000 and 283 in 2005 (USDOC, Bureau of the Census, 2001; ADCED, 2006). Ambler was settled permanently in 1958, when people from Shungnak and Kobuk moved upstream because of the variety of fish, wild game, and spruce trees in the area. Residents are Inupiat and follow a traditional subsistence lifestyle. Chum salmon and caribou are the primary subsistence-food resources, but freshwater fish, moose, bear, and berries are also important (Besse, 1983; Schroeder, Andersen, and Hildreth, 1987; Schroeder et al., 1987; ADCED, 2006).

About 150 mi east of Kotzebue on the west bank of the Kobuk River sits the village of Shungnak. Historically, the original settlement was located further upstream at Kobuk. This village population in 2000 was 256 residents and 259 residents in 2005 (USDOC, Bureau of the Census, 2001; ADCED, 2006). This Inupiat community was founded in 1899 as a supply point for local mining activities but was forced to relocate in the 1920's because of river erosion and flooding. The original site, 10 mi upstream, was renamed Kobuk by those who remained. Shungnak residents depend mainly on fishing, seasonal employment, hunting and trapping. Primary subsistence resources include sheefish, whitefish, caribou, moose, ducks, and berries (Besse, 1983; Schroeder, Andersen, and Hildreth, 1987; Schroeder et al. 1987; ADCED, 2006).

The Inupiat community of Kobuk is the smallest village in the Northwest Arctic Borough, with only 109 residents in 2000 and 130 in 2005 (USDOC, Bureau of the Census, 2001; ADCED, 2006). It is found on the right bank of the Kobuk River, 128 mi northeast of Kotzebue. The village began as a supply point for local mining and was originally called Shungnak until flooding and erosion forced resettlement 10 mi downstream. The few remaining residents renamed the site Kobuk. The local subsistence economy depends heavily on the harvests of whitefish, caribou and moose (Besse, 1983; Schroeder, Andersen, and Hildreth, 1987; Schroeder et al., 1987b; ADCED, 2006).

Ninety miles east of Kotzebue, Selawik sits at the mouth of the Selawik River where the river enters Selawik Lake. The community is near the Selawik National Wildlife Refuge, a key breeding and resting spot for migratory waterfowl. In 2000, Selawik had 772 residents and in 2005 it had 830 (USDOC, Bureau of the Census, 2001; ADCED, 2006). This Inupiat community practices traditional subsistence hunting and fishing. Important subsistence resources are whitefish, sheefish, caribou, moose, ducks, ptarmigan and berries. Occasionally, bartered seal and beluga whale supplement the diet (Besse, 1983; Schroeder, Andersen, and Hildreth, 1987; Schroeder et al., 1987; ADCED, 2006).

Buckland, located on the West Bank of the Buckland River and 75 mi southeast of Kotzebue, is an Inupiat village focused primarily on subsistence fishing and hunting. At least five times in its recent past, Buckland residents have relocated along the Buckland River to places known as Elephant Point, Old Buckland, and New Site. The village had 406 residents in 2000 and 434 in 2005 (USDOC, Bureau of the Census, 2001; ADCED, 2006). Important subsistence resources are reindeer, beluga whale and seal. A herd of more than 2,000 reindeer is locally managed, and workers are paid in meat (Besse, 1983; Schroeder, Andersen, and Hildreth, 1987; Schroeder et al., 1987; ADCED, 2006).

Fifty-seven miles southwest of Kotzebue, Deering is located on Kotzebue Sound at the mouth of the Inmachuk River. It sits on a long, narrow sand and gravel spit. The village, like others in the region, was founded as a supply point for local gold mining further inland. Deering's economy is a mix of cash and subsistence activities. The community maintains a local reindeer herd of 1,400 animals that provides local employment. Another regional Inupiat community, it had 136 residents in 2000 and 139 in 2005 (USDOC, Bureau of the Census, 2001; ADCED, 2006). Primary subsistence-meat sources are moose, seals, and beluga whales with pink salmon, tom cod, herring, ptarmigan, rabbit, and waterfowl supplying the rest (Besse, 1983; Schroeder, Andersen, and Hildreth, 1987; Schroeder et al., 1987; Huntington, 1999; ADCED, 2006).

III.C.2.c(3)(h) Shishmaref and Wales. Although outside of the Sale 193 Planning Area, the communities of Shishmaref and Wales on the northern coast of the Seward Peninsula, also are discussed briefly, because the oil-spill-risk analysis for Sale 193 included the coastline as far south as the Bering Strait in its trajectory simulations. Potentially, important coastal and nearshore subsistence harvest areas could be contacted in the event of a large oil spill.

Shishmaref, 126 mi north of Nome, 100 mi southwest of Kotzebue, and just north of Bering Strait, is situated 5 mi from the mainland on Sarichef Island in the Chukchi Sea. The village is surrounded by Bering Land Bridge National Reserve lands and is part of the Beringian National Heritage Park. The Inupiat community had 562 residents in 2000 and 581 in 2005 (USDOC, Bureau of the Census, 2001; ADCED, 2006). Shishmaref became a supply point for gold mining in the region in 1900 due to its exceptional harbor. The community is subject to severe storm erosion, with major storm events since 1997 causing the relocation of many homes and the National Guard Armory. Storms erode an average of 3-5 ft of shoreline annually on the north shore of Sarichef Island, and residents have agreed to relocate the community as soon as planning efforts and funding allow it to happen. Community subsistence harvests depend on reliable access to fish, walrus, seals, polar bears, and small game. Residents manage two reindeer herds; the reindeer skins are locally tanned and meat is available to the community (ADCED, 2006).

Wales is found on Cape Prince of Wales at the western tip of the Seward Peninsula, 111 mi northwest of Nome. This Inupiat community had 152 residents in 2000 and 151 in 2005 (USDOC, Bureau of the Census, 2001; ADCED, 2006). Until decimated by the influenza epidemic of 1918-1919, the village was the region's largest village, with more than 500 residents. Wales became a major aboriginal whaling center

due to its prime location along whale migration routes. Whales, seals, walruses, polar bears, moose, salmon, and other fish are the main subsistence resources. A reindeer herd is managed in the vicinity of Wales, and local residents participate in the harvest. The area has had a number of archaeological excavations over the years, and a burial mound of the “Birnirk” culture (500 A.D.-900 A.D.) discovered near Wales is now a national landmark (ADCED, 2006).

Subsistence community descriptions for the Kotzebue Sound region, Shishmaref, and Wales are discussed in brief because the percent chance of potential oil-spill contact is so low here. Oil-spill-risk analysis (OSRA) annual conditional contact values for ERA’s 5 and 13 (the primary coastal subsistence harvest areas for Kivalina, Kotzebue Sound region communities, and Shishmaref) and Land Segments (LS’s) 40 through 64 (coastal areas extending north from Wales to Point Hope) are, for the most part, <0.5% for 3, 10, 30, 60, 180, and 360 days after a potential spill. The only Land Segment or ERA that is contacted more is ERA 13 that has a 1% contact from pipeline segment P-1 in summer after 30 days.

III.C.2.c(3)(i) Russian Northern Chukchi Sea Coastal Communities. Indigenous Chukotkan peoples on the eastern shore of the Chukchi Sea are citizens of the Chukotsky Autonomous Okrug (Chukotka), an autonomous province of the Russian Confederation formed in 1991 after the collapse of the Soviet Union. Administratively, an *okrug* is specifically established for indigenous peoples. In 1989, the population was 160,000 and 90% of those living in Chukotka were immigrants, primarily employed in the mining and construction industries. In 2001, Chukotka had a population of 68,900 with 68% living in urban areas and 32% in rural areas. Of this rural population, 11,914 were Chukchi and 1,452 were Inuit (Newell, 2004). In 2004, the population was 55,245 (urban 37,084; rural 18,161) (Gray, 2006).

Of potential concern are the coastal communities along the Arctic Chukchi Sea coast from East Cape on the Chukotkan side of the Bering Strait to Cape Billings and Wrangel Island 450 mi to the north and west. Although outside of the Sale 193 Planning Area, these communities are discussed briefly because the OSRA for Sale 193 included the Chukotkan coastline as far east as Wrangel Island in its trajectory simulations.

Potentially, important coastal lagoons and nearshore subsistence-harvest areas for beluga, gray, and bowhead whales; walruses; seals; fish; and birds could be contacted in the event of a large oil spill. The *okrug* government has granted the indigenous peoples of the region the right to harvest 169 (presumably gray and beluga) whales, 10,000 ringed seals, and 3,000 walrus yearly. Reindeer herding is traditionally an important indigenous practice providing jobs, income, and playing a key role in culture, but herds have been in steep decline since the disappearance of government subsidies and markets for the meat and hides. The Chukotkan herds declined from 464,457 animals in 1985 to just 148,000 in 1998 (Newell, 2004; Mymrin 1999).

The arctic tundra region starting at East Cape and extending 200 mi west includes the coastal indigenous communities of Naukan (population 350); Uelen (population 678); Inchoun (population 362); Chegitun (a seasonal subsistence camp?); Enurmino (population 304); Neshkan (population 628); Alyatki (a seasonal subsistence camp?); Nutpel’men (population 155); and Vankarem (population 186). Naukan, Chegitun, and Alyatki may be recently reoccupied seasonal hunting and fishing sites. Uelen, Inchoun, Enurmino, Neshkan, Nutpel’men and Vankarem are permanent indigenous settlements, where subsistence hunting and fishing occur year-round. Both Naukan and Uelen are important areas for hunting polar bears. The area west of Inchoun, including the communities of Enurmino and Neshkan, was particularly hard hit by the socioeconomic disintegration of the 1990’s. Sources describing community infrastructure, human and resource populations, and harvest practices are minimal for this region (Schweitzer, 2005, pers. comun.).

Information for the coastal communities from Vankarem west and north to Cape Billings is almost completely lacking, but historically there were a number of indigenous settlements in the region. In general there has been a trend toward repopulating settlements (and reoccupying seasonal hunting and fishing camps) abandoned earlier due to forced relocation by the Soviet government into larger urban and centralized communities. Repopulation also has occurred to exploit natural food sources, as subsidies from Moscow to support employment and infrastructure have disappeared. The coastal settlements westward from Vankarem are Rigol (population unknown); Mys Shmidta (Cape Shmidt; population 717); Rypkarpyy (population 915); Polyarnyy (population unknown); Pil’gyn (population unknown); Leningradskii (population 835); Billings (Cape Billings; population 272), and Ushakovskoe (population 8) on Wrangel

Island. Of all these named settlements, only Ushakovskoe is known to still have functioning subsistence-harvest practices. Many names that still appear on maps of the region are historical villages that no longer exist and, in some cases, they may be small family camps where a few Native inhabitants live on a seasonal basis (Schweitzer, 2005, pers. commun.; Gray, 2006).

During the Soviet period, Cape Shmidt was an important military base and seaport; since the Soviet decline, personnel have been withdrawn and shipping along the Northern Sea Route is sporadic to nonexistent (Newell, 2004; Nuttall, 2005). According to Schweitzer (2005), “since the population decline in Shmidt was primarily due to the outmigration of non-Natives, subsistence might not have been affected too much (and, it is quite possible, that the relative weight of subsistence and subsistence foods increased due to economic hardship)” (Schweitzer, 2005, pers. commun.). This signature may have been followed in other settlements in the region.

The notion of “subsistence” as understood in Alaska does not exist in the Russian context. “This is part of a Soviet legacy to include Native labor into a wider scheme of economic development, that is reindeer herding and sea-mammal hunting (and other “subsistence” activities) were seen as part of the agricultural sector” (Schweitzer, 2005, pers. commun.).

Under the Soviet regime, smaller indigenous, coastal communities were forcibly relocated and put to work raising silver and arctic foxes in subsidized government animal farms. The harvest of whales, walrus, and seals was intensive and under strict government control, but Native peoples were given the meat to eat. Byproducts of the marine mammal hunt were used as animal feed for the foxes. Fox production cost from 3-5 rubles for every ruble of profit. When subsidies stopped, most of the fox farms were forced to close (Newell, 2004; Nuttall, 2005).

Reindeer herding under collectivization became a subsidized form of meat production. Government officials insisted on expanding the herd in the 1960’s despite the lack of adequate grazing areas. By the 1970’s, the herd had reached 576,000 animals and had begun to decline due to disease and depletion of grazing areas (Newell, 2004; Nuttall, 2005).

With the dissolution of the Soviet Union, collective enterprises reverted to small farms, which indigenous peoples initially saw as an opportunity to develop their own economic independence; however, subsidies, lack of markets, and high transportation costs are making this transition very difficult. Many reindeer herds and farms near urban areas have failed, and local herders do not have true ownership of the herds. Reindeer are sold for much less than they are worth, and many herders have been forced to subsist on their own herds for food. Money earned often is spent on alcohol (Newell, 2004; Nuttall, 2005). Grazing areas remain unprotected, and there is an overall degradation of the economy and the herding culture (Newell, 2004; Nuttall, 2005). Much of the rural indigenous population is struggling to get by or falling into poverty (Gray, 2006). In some cases, population and industrial declines have led to lower anthropogenic pressures on ecosystems, but these conditions have increased poaching levels due to increased unemployment and the lack of adequate food supplies. Regardless of the divergent Russian conceptualization of “subsistence,” the indigenous peoples of Chukotka continue to be dependent on the availability of animals and other natural resources (Newell, 2004; Nuttall, 2005; Schweitzer, 2005, pers. commun.).

Intensive industrialization, massive immigration, forced acculturation, and the collapse of Soviet economic and employment supports has taken a huge toll on the indigenous peoples of the region. “Essential material, social, and spiritual aspects of Arctic civilization and ecology [have begun] to disappear...Chukotka’s native peoples suffered greatly; in particular, most hunters of marine mammals [have] lost their spiritual reverence of the prey that they killed” (Chance and Andreeva, 1995; Newell, 2004; Nuttall, 2005).

These conditions have, ironically and out of necessity, brought coastal Native peoples closer to nature and turned them again toward their traditional reliance on hunting and fishing of marine resources, and their traditional diet of marine mammals, fish, marine invertebrates, and other locally harvested resources such as small game. Some income is earned from trading in furs, walrus ivory, and other products derived from local hunting and fishing. Surplus fish and meat and locally produced handicrafts are traded in nearby urban centers and sometimes sold to tourists. Coastal residents have revived traditional kayak building practices and sled-dog training. A bone-cutting shop has been developed by local craftsmen in Uelen, and

other small sewing shops have sprung up near collective farms and in homes. Local animal hides, fur, bones, and tusks are used as raw materials. Equipment is poor, delivery of product is difficult, and profits are small, yet their does seem to be a future for such enterprises (Newell, 2004; Nuttall, 2005).

In 1994, the NSB Wildlife Management Department signed a cooperative agreement with the Eskimo Society of Chukotka to assist them in rebuilding their whaling traditions by supplying them with equipment and weapons to facilitate the gray whale harvest, to assist in annual bowhead whale counts, and in obtaining a bowhead whale quota from the IWC (North Slope Borough, 1997). From data collected through this collaboration, the IWC granted Russia rights to hunt up to five bowhead whales, although in 2002 the IWC reversed its earlier decision and revoked this right. In the last decade, whaling practices, particularly the gray whale harvest, have experienced a revival out of conditions spawned by the collapse of collectivization. Whale and walrus hunting is concentrated in the months of July through October but gray whales can be taken in June (North Slope Borough and USDO, National Park Service, 1999; Newell, 2004; Nuttall, 2005).

Native leaders and activists are forming nongovernmental organizations to support indigenous concerns and initiatives. The Association of Native Minorities of Chukotka, The Eskimo Society of Chukotka, reindeer-herder organizations, and marine mammal-hunters' associations, such as the Union of Marine Mammal Hunters of Chukotka, recently have been formed. These organizations intend to restore traditional practices for resource use and also introduce conservation regimes. Some of these organizations are recruiting Native peoples to inventory and manage bowhead whale, walrus, and polar bear populations. There also is an active exchange with Finland and Norway to share reindeer-herding knowledge (Newell, 2004; Nuttall, 2005; Schweitzer, 2005, pers. commun.).

In recent years, Moscow has effectively abandoned developing infrastructure and viable energy sources for the smaller coastal settlements although, under Governor Abramovich, dramatic improvements have occurred along the Chukchi Sea coast. Abramovich has invested in the "subsistence industry"—reindeer herding and fur farming—with the intent of making these profitable or break-even ventures (Newell, 2004; Nuttall, 2005; Schweitzer, 2005, pers. commun.).

If offshore oil and gas leasing becomes a reality in the region, and spill scenarios point to potential impacts on the Russian side of the Chukchi Sea, "social and cultural impact assessments would have to be made from scratch, given the paucity of available data and the fast-changing socioeconomic environment of recent years." Yet current political conditions in Chukotka would present no major obstacles toward conducting the necessary research to develop such assessments (Schweitzer, 2005, pers. commun.).

III.C.2.d. Arctic Climate Change.

In the Arctic, a factor of increasing concern is the potential for adverse effects on subsistence-harvest patterns and subsistence resources from habitat and resource alterations due to the effects of global climate change. The Council on Environmental Quality (CEQ) provides guidance on National Environmental Policy Act (NEPA) regulations and its mandate to consider all "reasonably foreseeable" environmental impacts of a proposed Federal action in a NEPA assessment. Based on current scientific evidence (e.g., the *Second Assessment Report* by the Intergovernmental Panel on Climate Change [IPCC]), the CEQ considers that there is adequate scientific evidence indicating that climate change is a "reasonably foreseeable" impact of greenhouse gas emissions (CEQ, 1997; IPCC, 2001a,b).

Permafrost thawing is expected to continue to damage roads and buildings and contribute to eroding coastlines and increase building and maintenance costs in the Arctic. The cost of shifting buildings, broken sewer lines, buckled roads, and damaged bridges already has caused \$35 million worth of damage annually in Alaska. In Kotzebue, the local hospital had to be relocated, because it was sinking into the ground (ARCUS, 1997). Sea-level rise and flooding threaten buildings, roads, and power lines along low coastlines in the Arctic and, combined with thawing permafrost, can cause serious erosion. Kaktovik's 50-year-old airstrip has begun to flood because of higher seas, and may need to be moved inland (Kristof, 2003). Shore erosion in Shishmaref, Kivalina, Point Hope, Wainwright, and Barrow in Alaska and Tuktoyaktuk at the mouth of the MacKenzie River in Canada has become increasingly severe in recent years, as sea-ice formation occurs later, allowing wave action from storms to cause greater damage to the shoreline.

The duration of ice-road usefulness in the Arctic already has diminished by weeks and has led to an increased need for more permanent gravel roads. However, gravel roads are more prone to the effects of permafrost degradation, thermocarst, and consequent settling that increases maintenance costs (Nelson, 2003). Gravel roads also contribute to the fragmentation of landscapes and habitats that can lead, through time, to reduced species' productivity and availability.

Continuing sea-ice melting and permafrost thawing could threaten subsistence livelihoods. Typically, peoples of the Arctic have settled in particular locations because of their proximity to important subsistence-food resources and dependable sources of water, shelter, and fuel. Northern peoples and subsistence practices will be stressed to the extent that these following observed changes continue:

- settlements are threatened by sea-ice melt, permafrost loss, and sea-level rise;
- traditional hunting locations are altered;
- subsistence travel and access difficulties increase; and
- game patterns shift and their seasonal availability changes.

Large changes or displacements of resources are likely, leaving little option for subsistence communities: they must quickly adapt or move (Langdon, 1995; Callaway, 1995; *New Scientist*, 2002; Parson et al., 2001; AMAP, 1997; *Anchorage Daily News*, 1997; Weller, Anderson, and Nelson, 1998; IPCC, 2001a). Great decreases or increases in precipitation could affect local village water supplies, shift the migration patterns of land mammals, alter bird breeding and molting areas, affect the distribution and abundance of anadromous and freshwater fish, and limit or alter subsistence access routes (particularly in spring and fall) (AMAP, 1997). Changes in sea ice could have dramatic effects on sea mammal-migration routes and this, in turn, would impact the harvest patterns of coastal subsistence communities and increase the danger of hunting on sea ice (Callaway et al., 1999; Bielawski, 1997). Between 1980 and 2000, three sudden ice events caused Barrow whalers to abandon their spring whaling camps on the ice lead (George et al., 2003; National Assessment Synthesis Team, 2000; Groat, 2001).

III.C.3. Sociocultural Systems.

As we use the term in the analysis of potential effects of OCS activities, "sociocultural systems" encompasses three concepts: social organization, cultural values, and institutional organizations of communities. By "social organization" we mean how people are divided into social groups and networks. By "cultural values" we mean concepts about what is desirable that are widely shared explicitly or implicitly by members of a social group. By "institutional organization" we refer to the government and nongovernment entities that provide services to the community.

These concepts are interrelated. For most Alaskan Natives, if not all, subsistence (and the relationship between people, land, water, and its resources) is the idiom of cultural identity, and production of subsistence foods is the activity around which social organization occurs. Institutional organizations, in turn, reflect and affect the social organization and cultural values. For the North Slope of Alaska, the Inupiat traditions and practices largely define social organization and cultural values while the civil and tribal governments and Native corporations largely define institutional organization.

We look at a number of characteristics in order to describe these three concepts. Social organization encompasses households and families, but wider networks of kinship and friends which, in turn, are embedded in groups that are responsible for acquiring, distributing, and consuming subsistence resources. Cultural values, many of which are rooted in, maintained, and reinforced by the interrelatedness of social organization, include close relationship with natural resources, emphasis on kinship, maintenance of the community, cooperation, and sharing. Subsistence is a central activity that embodies these values, with bowhead whale hunting the paramount subsistence activity. Institutional arrangements focus primarily on the structure of borough, village, and tribal government, and the Native regional and various village for-profit and not-for-profit corporations, but could include extended institutional arrangements, for example, voluntary organizations such as Search and Rescue, volunteer fire departments, and so on

III.C.3.a. Social Organization.

The social organization of NSB communities has been described in detail in a number of recent environmental impact statements and environmental analyses (USDOI, BLM and MMS, 2003; USDOI, BLM, 2005; USDOI, MMS, 2003a, 2006a). As described in these analyses, the broad-model North Slope social organization prior to Euro-American contact consists of a dynamic system composed of small kinship-based territorially defined “nations” of subsistence hunters. Although Euro-American contact greatly influenced Inupiat social organization, the fundamental organizational feature is that of kin-related groups engaged in subsistence activities. Euro-American contact introduced new resources (such as food items and technology) that enhanced subsistence hunting and wage-earning opportunities, and also introduced many other agents of change. Development of the oil industry on the North Slope transformed the economic basis on which the North Slope region as a whole operated, but not the importance of kinship-based social organization. The influences that affect social organization include:

- Adaptation to new technology, pressures, and legal/regulatory actions introduced through successive waves of contact between Natives and non-Natives starting with whaling in the 19th century and continuing through oil and gas development in the 21st century.
- Change in settlement patterns with greater centralization into larger, more sedentary communities.
- Continuation of pattern of centralized leadership of whaling captains and their families, cultural and nutritional dependence on subsistence foods, reliance on sharing and kinship, connection to family camps and traditional use areas, and a desire to control destination of their communities.

III.C.3.b. Cultural Values.

The Inupiat culture on the North Slope has strong ties to the natural environment. Traditional activities are central to the historic and contemporary lifestyles, with subsistence seasons focusing subsistence activities. Family and kinship relationship are strong influences on contemporary life, shaping social interactions including cooperative activities and sharing. Cultural values of the Inupiat include characteristics such as respect for Elders, cooperation, sharing, family and kinship, knowledge of language, hunting traditions, and respect for nature. Borough residents express concerns regarding effects of oil and gas activities on archaeological, historic, and traditional land use and the incorporation of traditional and contemporary local knowledge into development projects (URS Corporation, 2005:68-70).

The NSB 2003 Economic and Census Report highlights a number of indicators that show the strength of cultural ties in communities (Shepro, Maass, and Callaway, 2003). The report shows a high level of participation in subsistence activities independent of income, occupation, and education levels. With variation from community to community, sharing remains strong, although there has been a decline in the absolute number of households sharing one-half or more of their harvest. Furthermore, the sharing of food within and between NSB communities has increased while sharing with communities beyond the NSB has generally decreased. Participation in subsistence activities is cited in only a few instances as the reason for unemployment in the communities. Where reported, about one-fifth of the households in a community derive some income from the production and sale of Native crafts. The report concludes that “use of subsistence resources remains an important aspect of life for Inupiat households, both in terms of the maintenance of cultural and traditional values and as a means to put food on the table.”

The report also examines two other aspects of Inupiat culture. Respect for elders remains high in all the communities. The status of Inupiat language fluency is less clear. Fluency appears to vary between communities and with age. A majority of the older residents are much more fluent than younger residents. The NSB government and schools have undertaken a number of initiatives to preserve and increase Inupiat language fluency.

Residents of the North Slope and in Chukchi Sea coastal communities have been remarkably consistent in their primary concerns during the more than 20 years of public hearings and meetings on State and Federal oil development on the North Slope and in Northwest Alaska. USDOI, MMS, 1996c, 1998b; U.S. Army Corps of Engineers, 1999, incorporated herein by reference). Cultural concerns mentioned include:

- The effects that oil spills are likely to have the largest and longest lasting effects on the Inupiat people, primarily in terms of subsistence activities.
- There is a general fear of cultural change, especially in terms of the loss of a subsistence lifestyle, which may lead to social disruptions or social problems in local communities (including youth becoming less interested in traditional ways).
- Oil development will result in an influx of population and other influences, which will disrupt and degrade Inupiat community life. In addition, oil development and its effects will impose additional demands upon Inupiat communities and individuals (and appearances at numerous hearings and the review of numerous documents are only the most visible of such demands).

III.C.3.c. Institutional Organization.

The government and nongovernmental organizations that make up the institutional organization of the area include the NSB, city governments, Tribal government, Alaska Native Regional Corporations, village corporations, nonprofit corporations, and nongovernmental organizations, such as the AEWC.

A recent MMS report noted that the linkages that have evolved over the years between these entities formed a network that facilitates a transfer and flow of material and nonmaterial resources. The report concluded that the social embeddedness created by interlocking ties of the network helped ensure that economic development of the North Slope was shaped by shared value systems and needs in the local communities (Northern Economics, Inc., 2006).

III.C.3.c(1) North Slope Borough. The formation of the NSB in 1972 was motivated, in part, by the desire to capture petroleum industry-based property tax revenue for local improvement and exercise a degree of control over the pattern of petroleum development through the permitting of onshore oil infrastructure. Other factors that contributed to the motivation include the exercise of local control over Federal education and health care and provision of services by the State that were lacking compared to other communities. Communities have deliberately transferred municipal power to the borough government including basic community services in 1974, education in 1975 with the formation of the North Slope School District, and public safety in 1976. The result has been a strong regional government (Northern Economics, Inc., 2006).

The NSB revenue sources include property taxes and other sources such as state and federal government, mainly for health and education programs; state revenue sharing and grants-in-aid, and fees for NSB-provided utilities and services. However, revenue the Borough receives in property taxes far exceeds that received from the other sources. As noted in Section III.C.1, Economy, the petroleum industry provides the high value tax base for the Borough. The oil and gas industry provides the primary source of revenue for NSB government (just under \$200 million in 2003).

Borough expenditures fall into three general categories: operating budget (public services, education, and general government), debt service, and capital expenditures. Operating expenditures and debt service are primarily financed with property tax revenues, while capital expenditures are financed through general obligation bonds which contribute, in turn, to expenditures for debt service. Historically, public services have consumed the largest portion of the operating budget, followed by education and local government expenses.

The NSB provides nearly all municipal services to the villages, including the operation of basic services and facilities. The Borough's Capital Improvement Program (CIP) created most of the infrastructure that serves the needs of the communities. Through the provision of these services, the Borough either directly or indirectly provides the majority of full-time employment in the cities. The Borough, through its functions and powers, channels Federal and State funds and property tax revenues to the Borough's cities in terms of public facilities, programs, and services. The NSB government and the School District are the largest employers in the region. However, in the period from 1998 to 2003, NSB government employment declined as did employment in the CIP, primarily due to the completion of construction projects in communities outside of Barrow (Shepro, Maass, and Calaway, 2003).

Over the last 25 years, these services have significantly improved the economic- and social-well being for borough residents in areas of health, social services, public safety, education, communications, and

transportation. In each sector, action by the NSB has demonstratively led to improvements compared to pre-Borough service levels. The Borough provides the utilities in each of the communities, where a large majority of housing units are now connected to public water and sewers. The NSB Department of Health directly or indirectly provides a hospital in Barrow and health clinics in outlying villages. Social services furnished by the Borough include housing, meals and transportation for seniors, mental health counseling, and day care. The Borough provides each of the villages with full-time law enforcement, fire protection, and search and rescue services with a combination of full-time employees and volunteers. Secondary school facilities have been provided in each village, and postsecondary education opportunities have improved. The Borough owns and operates public airports in all the communities, except Barrow and Deadhorse, and fosters community well-being through creation and support of other institutions, such as the Commission on Inupiaq History, Language, and Culture.

Since peaking in 1986, oil and gas property-tax revenues have declined as the value of the oil production and pipeline infrastructure depreciates. As the revenues have declined, borough expenditures have similarly declined.

III.C.3.c(2) Community Profiles and Organization. Each of the Borough's communities, with the exception of Point Lay, has a city government. While certain municipal powers were turned over to the Borough, community governments play an important role in the administration of Borough programs and representing community interests. In addition, local governments administer some State and Federal programs, such as capital improvements and housing (Northern Economics, Inc., 2006).

III.C.3.c(2)(a) Barrow. Barrow is the largest community on the North Slope and is its regional center. In 1970, the Inupiat population of Barrow represented 91% of the total population (USDOC, Bureau of the Census, 1971) but by 1990, Inupiat representation had dropped to 63% and remains approximately there today. Between 1980 and 1985, Barrow's population grew by 35% (Kevin Waring Assocs., 1989). Barrow's population stood at 4,351 in 2004 (ADCED, 2005). The dramatic change in population and demographics is due primarily to the impacts of oil and gas development. Increased revenues from onshore oil development and production at Prudhoe Bay and in other smaller oil fields have fueled the change. These revenues stimulated NSB CIP's which, in turn, stimulated a boom in Barrow's economy and an influx of non-Alaskan Natives to the community. The social organization of the Barrow community has become diversified with the proliferation of formal institutions and the large increase in the number of different ethnic groups. Traditional marine mammal hunts and other subsistence practices are still an active part of the culture. The sale of alcohol is banned in the community, although importation or possession is allowed.

As the seat of borough government and the largest regional community, facilities include hospitals, government office buildings, recreation and cultural facilities, a public safety office and two fire stations. Piped water serves most households with others being served by a water-haul system. A sewer system serves most households (others use a septic/honey-bucket system). Solid waste is disposed of in a Class II landfill with a design life through 2050 (URS Corporation, 2005).

III.C.3.c(2)(b) Atqasuk. Atqasuk is a small, predominantly Inupiat community on the Meade River, about 60 mi south of Barrow. In 2000, there were 228 residents, 94.3% of whom were Inupiat; in 2004, there were 247 community residents (ADCED, 2005). The area traditionally has been hunted and fished by Inupiat Eskimos. The name means "the place to dig the rock that burns." During World War II, bituminous coal was mined in Atqasuk and freighted to Barrow for use by government and private facilities. The community was established in mid-1970 under the Alaska Native Claims Settlement Act (ANCSA) by Barrow residents who had traditional ties to the area. People lived in tents until NSB-sponsored housing arrived in 1977. The 1980 Census tallied 107 residents; 2 years later, a Borough census recorded 210 residents. By July 1983, the population had risen to 231, a 166% increase since the first census in 1980.

Atqasuk is an inland village, and its subsistence preferences are caribou and fish. Grayling, whitefish, caribou, geese, ptarmigan, polar bears, seals, walruses, and whales are harvested and traded. Residents trap and sell furs to supplement cash income. Social ties between Barrow and Atqasuk remain strong, and men from Atqasuk go to Barrow to join bowhead whaling crews. To a large degree, Atqasuk has avoided the rapid social and economic changes experienced by Barrow and Nuiqsut brought on by oil-development

activities, but future change could accelerate as a result of oil exploration and development in the Northwest NPR-A. Possible new pipeline routes could cross Atqasuk's terrestrial subsistence-harvest areas, as most of its traditional subsistence-use area is within the NPR-A (USDOI, BLM and MMS, 2003).

Community facilities include a health clinic staffed by community health aides, community building, police station, and fire station. Piped water serves most households with others being served by a water-haul system. A sewer system serves most households (others use a septic/honey-bucket system). Solid waste is disposed of in a Class III landfill with a design life through 2050 (URS Corporation, 2005).

III.C.3.c(2)(c) Wainwright. Wainwright is located on the Chukchi Sea 100 mi southwest of Barrow on the western boundary of the NPR-A. In 2004, Wainwright's population was 531 (ADCED, 2005). The population declined precipitously from the late-1990's and is in part attributed to outflow of workers from the community after the completion of water and sewer projects funded by the CIP (Shepro, Maass, and Calaway, 2003).

As in other North Slope communities, the changes in Wainwright from 1975-1985, stimulated by the NSB CIP boom, are not as dramatic as the changes in Barrow. Nonetheless, the CIP led to retention of the population and the creation of new jobs, housing, and infrastructure. Although there has been an influx of non-Natives into Wainwright, most are transient workers and cannot be considered permanently settled or even long-term residents. In 1989, approximately 8.7% of all Wainwright residents were non-Native (NSB, Dept. of Planning and Community Services, 1989). This was a decrease from 30% non-Alaskan Native in 1983 (Luton, 1985) and is most likely a direct result of the end of the NSB CIP boom. Of these approximately 43 residents, only a few remained in Wainwright 6 months to a year later. The Caucasians in Wainwright tend to be nonpermanent, mobile residents who have relatively little interaction with the Native population (Luton, 1985).

The Wainwright CIP has not only been central to the local economy, but it also has changed the face of the community and affected the quality of life. Residents now live in modern, centrally heated homes with running water, showers, and electricity. New buildings dominate the town, and upgraded roads have encouraged more people to own vehicles. Between July 1982 and October 1983, the number of pickup trucks and automobiles in Wainwright more than tripled (Luton, 1985). All of Wainwright's subsistence marine resources are harvested in offshore in the Chukchi Sea, and all of the community's terrestrial subsistence use areas are within NPR-A (USDOI, BLM and MMS, 2003). Bowhead and beluga whales, seals, walruses, caribou, polar bears, birds, and fishes are harvested. Sale of local Eskimo arts and crafts supplements income.

Community facilities include a health clinic staffed by community health aides, city hall, police station, fire station, senior center and day care center. Piped water, water haul, and a sewer system serve the community. Solid waste is disposed of in a Class III landfill with a design life through 2020 (URS Corporation, 2005).

III.C.3.c(2)(d) Point Lay. Point Lay is one of the more recently established Inupiaq villages on the arctic coast, and has historically been occupied year-round by a small group of one or two families. The community has the smallest population of any community in the NSB, with a population of 251 in 2004, and is the only unincorporated community in the NSB (ADCED, 2005). About 90 mi southwest of Wainwright, the community sits on the Chukchi Sea coast at the edge of Kasegaluk Lagoon near the confluence of the Kokolik River and Kasegaluk Lagoon.

The community was established in the 1920's and its number of residents increased until the 1930's, when its population began a slow decline, largely because of the decline in reindeer herding. By 1960, it was not included in the national census. The village was reestablished on a barrier island spit opposite the Kokolik River in the 1970's (motivated by the terms of ANCSA). Residents of Barrow, Wainwright, Point Hope, Kotzebue, and other Inupiat with traditional ties to the area resettled here. The town then moved to its present mainland site south of the Kokolik Delta in 1981. In 1983, a NSB census recorded 126 residents in the community. Local employment during this period revolved around the DEW Line site and Borough CIP projects. Smaller Borough-, village corporation-, and State-funded construction projects continue to employ local workers on a temporary basis, and the NSB government remains the largest local full-time employer (USDOI, BLM and MMS, 2003).

Limited oil-exploration activity has occurred near Point Lay, with a well drilled 25 mi northeast of the community in 1981 on Arctic Slope Regional Corporation lands, the Tunalik #1 test well drilled within NPR-A inland and southeast of Icy Cape in 1978 and 1979. Both wells were plugged and abandoned. Point Lay is similar to Atqasuk in avoiding the rapid social and economic changes experienced by Barrow and Nuiqsut from past oil development activities.

Point Lay residents enjoy a diverse resource base, including marine and terrestrial animals. The community is unique because its wild food dependence is relatively balanced between marine and terrestrial resources; and unlike the other communities discussed, local hunters do not pursue the bowhead whale because the deeply indented shoreline has prevented effective bowhead whaling. However, the village participates in beluga whaling.

Community facilities include a health clinic staffed by community health aides, community center, police station, fire station, senior center, and day-care center. Piped water and a sewer system serve the community. Solid waste is disposed of in a Class III landfill with a design life through 2020 (URS Corporation, 2005).

III.C.3.c(2)(e) Point Hope. Point Hope residents, with a population of 726 in 2004 (ADCED, 2005) enjoy a diverse resource base that includes both terrestrial and marine animals. Bowhead and beluga whales, seals, caribou, polar bears, birds, fishes, and berries are important subsistence resources. The community, 330 mi southwest of Barrow, is located on a large gravel spit that forms the westernmost extension of the northwest Alaska coast. Once called Tigaraq, the peninsula has been occupied for at least 2,000 years and is one of the longest continuously occupied areas in Alaska. This likely is due to its proximity to marine mammal-migration corridors and favorable ice conditions that allow hunting in open leads early in the spring-whaling season. Local government is the main employer of Point Hope residents. Additionally, the local manufacture of Alaskan Native crafts also contributes to the community economy (U.S. Army Corps of Engineers, 2005).

The city government was incorporated in 1966 and, in the early 1970's, the community moved, because of erosion and periodic storm-surge flooding, to its present location just east of the old settlement. The Native Village of Point Hope is a federally recognized tribe and is active in community government and in providing services. The NSB provides all utilities to Point Hope and subsidizes fuel costs. No roads connect Point Hope with other communities. Point Hope has better facilities than many other communities of the region, but problems remain concerning high fuel costs, uncertain transportation, erosion, storm-surge flooding, unemployment, and the need for better utilities (Fuller and George, 1997; U.S. Corps of Engineers, 2005). The sale, importation, or possession of alcohol is banned in the village.

Community facilities include a health clinic staffed by community health aides, city hall, police station, fire station, senior center, and day-care center. Piped water and a sewer system serve the community. Solid waste is disposed of in a Class III landfill with a design life through 2010 (URS Corporation, 2005).

III.C.3.c(3) Tribal Government. Point Hope, Point Lay, Wainwright, and Barrow also have either a traditional village or Indian Reorganization Act Tribal council. Historically, these Tribal governments have provided some services and may partner with the borough to manage and operate social service programs. The Inupiat Community of the Arctic Slope, the regional tribal government, has recently taken a more active and visible role in regional governance and the provision of some services. Government-to-Government consultations with these tribal governments occur on major Federal actions directly affecting the tribes, including those associated with OCS oil and gas.

III.C.3.c(4) Alaska Native Corporations. Collectively, village corporations are the third largest employer and Arctic Slope Regional Corporation (ASRC) is the fourth largest employer in the region (Shepro, Maass, and Calaway, 2003:Table 5).

The ASRC runs several subsidiary corporations and along with village profit and not-for-profit corporations have provided employment and other services in the Borough's communities. For example, ASRC and village corporations provide employment and other public services to the communities, such as operation and maintenance of utilities, operation of the stores, hotels, and restaurants, and so on, while

nonprofit corporations are primarily involved in education, health/medical, public housing, and other community services through funding obtained from the Borough and Federal and State governments. An in-depth profile of the ASRC and Alaska Native village corporations for Atkasuk (Atkasuk Corporation), Point Lay (Cully Corporation), Wainwright (Olgoonik Corporation), Point Hope (Tikigaq), and Barrow (Ulkaevvik Inupiat Corporation) can be found in Northern Economics, Inc. (2006) and URS Corporation (2005). Generally, much of the surface estate in and around the communities is owned by the village corporations, except in Barrow where land ownership is a mixture of public (Federal, State, Borough, Tribal, and village) and private (Alaska Native regional and village corporations and private individuals).

Employment by village corporations generally is seen as being subsistence friendly. Among Alaska Natives, income does not appear to determine participation in subsistence activities, as households with high incomes regularly participate; nor is conflict with subsistence reported as a major reason for unemployment (Shepro, Maass, and Calaway, 2003). Regional and village corporations are creating some employment through subsidiaries and joint ventures and some companies involved in resource development have undertaken to increase local employment through training programs and other actions. Job requirements can create conflicts with subsistence activities, and the need to complete training and address substance abuse problems have been identified as challenges that must be overcome to increase employment (URS Corporation, 2005).

III.C.3.c(5) Nongovernmental Organizations. Nongovernment organizations, such as the AEWG and whaling captain's associations, play an important role in the management of resources vital to the subsistence and cultural needs of the communities.

III.C.3.d. Local Institutional Involvement with Development.

Local institutional influence on development is exercised by the borough and city governments, Tribal governments, and nongovernment organizations.

The largest local institutional influence on development is exercised through the Borough's Planning and Community Services Department. For example, the department's Permitting Section of the Land Management Regulation Division reviews land-use plans and permits, and monitors compliance with the land management regulations, the NSB Coastal Management Program and permit conditions through field inspections. The division coordinates and maintains contacts with other Borough departments, industry representatives, state and federal agencies, the planning and zoning commission, and village and city governments. Similarly, and unique in all Alaska, the Borough's Department of Wildlife Management plays a major role in managing important subsistence resources within the Borough.

City governments influence development through interaction with the Borough on issues that fall within each community's boundaries and beyond and by participation in the environmental assessment and permitting process for major Federal actions. Tribal governments (village government and the Inupiat Community of the North Slope) and nongovernment organizations exercise influence over development by representing the interests of their members and through their power of persuasion. For example, these entities play an important role in the crafting of conflict avoidance agreements and negotiation of the Good Neighbor policies that firms doing business in the community are encouraged to develop. However, residents of the community have expressed concerns that they have little effect on the outcome of development decisions (URS Corporation, 2005).

III.C.4. Archaeological Resources.

Archaeological Resources" can be defined as "any prehistoric or historic district, site, building, structure, or object [including shipwrecks]...Such term includes artifacts, records, and remains which are related to such a district, site, building, structure, or object" (National Historic Preservation Act, Sec. 301[5] as amended, 16 U.S.C. 470W[5]). Significant archaeological resources are either historic or prehistoric and generally include properties of >50 years that (1) are associated with events that have made a significant contribution to the broad patterns of our history; (2) are associated with the lives of persons significant in the past; (3) embody the distinctive characteristics of a type, period, or method of construction; (4) represent the work of a master; (5) possess high artistic values; (6) present a significant and distinguishable entity whose components may lack individual distinction; or (7) have yielded, or may be likely to yield, information

important in history. These resources represent the remains of the material culture of past generations of the region's prehistoric and historic inhabitants. They are basic to our understanding of the knowledge, beliefs, art, customs, property systems, and other aspects of the nonmaterial culture. The two major locational categories and two major time sequences of archaeological resources identified in the Sale 193 area are, respectively, offshore/onshore and prehistoric/historic.

III.C.4.a. Offshore Archaeological Resources.

Radiocarbon dates obtained by USGS on *in situ* freshwater peat samples in the Chukchi Sea yielded dates of $11,000 \pm 60$ radiocarbon years before present (RCYBP) from an elevation of -45.7 m and $11,330 + 70$ RCYBP from an elevation of -50.6 m below present sea level (USGS, 1991). Current archaeological data suggest that prehistoric human populations may have entered North America as early as 13,000 years B.P. when sea level would have been even lower. Due to a lack of specific data from the Chukchi Sea which would indicate where relative sea level stood at 13,000 years B.P., MMS is using the -60 m isobath as a conservative estimate of where the shoreline would have been in the Chukchi Sea at 12,000 years B.P. New information (Phillips, 1991) has led us to re-evaluate the age of the significant lower sea level still-stands and associated modern water depths, as well as the age of human occupation. We now believe that an age of 13,000 years B.P. is more approximate for the time of earliest human occupation, because onshore data show occupation at approximately 12,000 years B.P. and, therefore, areas beneath the current sea level might have been occupied earlier. Also, evidence now shows that the sea level stood at -45 m at approximately 11,000 years B.P. and at -50 m at 11,300 years B.P. Although no data are available for the time period of 13,000 B.P., we have adopted -60 m as the possible depth of the sea level still-stand, corresponding to approximately 13,000 years B.P. Along this portion of the now submerged shelf, relict terrestrial landforms provide indicators of areas where there is a higher potential for archaeological sites to occur. Currently, ice gouging is the only criteria for which there are sufficient published sources to document the level of probable destruction to archaeological sites (See Map 7).

A listing of shipwrecks in the Alaska OCS Region can be found on the MMS Alaska Shipwreck Database (USDOI, MMS, 2006d). Shipwrecks are likely to have survived in the sale area, especially those that may be at a depth beyond intensive ice gouging (Tornfelt, 1982; Tornfelt and Burwell, 1992). Between 1861 and 1950, historic accounts have identified 83 shipwrecks occurring either onshore or offshore within the Chukchi Sea Planning Area. Two potential shipwreck locations have been identified in the Chukchi Sea Sale 193 Area (see Map 7). In a 12-day period in September 1871, nearshore from Kuk Inlet north to Point Franklin and the Seahorse Islands, 32 whaling ships were crushed in the ice. Other whalers were lost in other incidents off Point Hope, Icy Cape, Point Franklin, and Barrow. No surveys of these shipwrecks have been made; therefore, no exact locations are known. The possibility exists that a number of these shipwrecks have not been completely destroyed by ice movement and storms. The probabilities for preservation are particularly high around Point Hope, Point Belcher, Point Franklin and Point Barrow. With some exceptions, the sites of most of these shipwrecks are within State waters; however, the best-preserved shipwrecks are likely to be found on the OCS because wave action and ice are less likely to contribute to the breakup of ships in deeper waters. It is not possible to tell which, if any, erosional processes have destroyed archaeological resources in the sale area until surveys have been conducted and interpreted (Tornfelt and Burwell, 1992; USDOI, MMS, 2006d; see Table III.C.18).

In 1998, the first scientific survey of the whaling wrecks off Wainwright was undertaken. Its mission was to locate the sunken New Bedford whaling fleet of 1871, which is located in approximately 25-52 ft of water off Point Belcher. Dubbed the Jeremy Project, the survey was made up of scientists from NASA, MMS, Ames Research Center, and Santa Clara University in California. Former MMS Alaska Region archaeologist, Michele Hope, served as team archaeologist for the Jeremy Project. The team worked from late August to early September during the open-water season with the help of the U.S. Coast Guard, the icebreaker *Polar Star*, and the U.S. Navy.

State-of-the-art equipment, originally developed by NASA's Ames Research Center for the Mars Pathfinder Project, was used to search for the wrecks. The team used Mars Pathfinder mapping programs, originally designed to map and analyze geological features of dry, planetary surfaces, to map the wreck sites. The first wreck was found by accident (because the side-scan sonar never became operational) while testing a special, remotely operated underwater vehicle (TROV) with mounted cameras that produce 3-dimensional pictures of an object. The remainder of the 2-week expedition was spent investigating that

site. While Navy divers were videotaping the first site, a second wreck was found. In all, four separate hull outlines may have been identified. Sites were mapped with GPS and were videotaped with the TROV and by divers (<http://quest.arc.nasa.gov/arctic/>; www.mms.gov/alaska/kids/atwork/jeremy/jeremy.htm; Bingham, 1998).

A follow-up marine archaeological expedition supported by the National Science Foundation and the Barrow Arctic Science Consortium took place in August 2005. Using specially designed compact side-scan sonar technology and an inflatable vessel, the small, shore-based team searched for the remains of the 1871 whaling wrecks. Historical research and Jeremy Project data dictated the location of the search area. Nearly 250 side-scan anomalies were recorded in the 13 mi² of sea bottom surveyed; of these hits, 71 were determined to be worthy of ground-truthing using a video camera. Unfortunately, weather conditions deteriorated and the field season expired before these anomalies could be explored or confirmed as potential wreck sites. Future fieldwork is planned to further evaluate them (Beebe and Jensen, 2006).

III.C.4.b. Onshore Archaeological Resources.

Information for some of the approximately 83 known archaeological sites onshore of the Sale 193 area may be found in the Alaska Heritage Resources Survey File (ADNR, 2006). State-listed sites WAI 008 through 015 are National Register sites as of March 18, 1980. Sites WAI 008, 010, and 011 are from the Kukmiut tradition; WAI 009 and 012 through 015 are from the Inupiat tradition. Twenty-one sites along the shore in the Wainwright Quadrant, 52 sites in the Point Lay Quadrant, and 10 sites in the Point Hope Quadrant exhibit just a small part of the archaeological-resource potential of the shore area along the Chukchi Sea coast. Historically, onshore archaeological resources near the Chukchi Sea coast receive less damage from the receding shoreline than do resources on the Beaufort Sea coast, which is subjected to more slumping because of water action and permafrost (Lewbel, 1984). The Chukchi Sea coast is eroding on an average of about 0.3 m per year. Although this erosion rate is considerably lower than that of the Beaufort Sea coast (1-2 m/yr), it accounts for a coast on which new archaeological sites periodically appear because of erosion. Known onshore archaeological resources exist in great numbers and quality. Emerging villages, graves, whaling camps, and fishing/hunting camps have been found (Tornfelt, 1982).

The Ipiutak Site National Historic Landmark at Point Hope, Cape Krusenstern National Monument, and the Bering Land Bridge National Preserve are particularly important onshore archaeological resources and are important to mention, because oil-spill transport far south of the actual Sale 193 Proposed Action area may impact these areas. To the north of the sale area, the Birnirk Site National Historic Landmark at Barrow also could be of concern due to the northern directional flow of offshore currents.

III.C.4.b(1) Cape Krusenstern National Monument. The core of this archaeological district lies in the Cape Krusenstern National Monument, south of the Sale 193 Planning Area. A complex of approximately 114 marine beach ridges occurs here. These beach ridges run roughly east-west, are parallel to the present shoreline, composed of alluvium, are only about 3 m above sea level, extend from 2.5-5 km toward the sea, and are about 14.5 km long. These beach ridges, formed of gravel deposited by major storms and regular wind and wave action, record in horizontal succession, the major cultural periods of the Arctic over the last 4,500 years. The prehistoric inhabitants of northwest Alaska seasonally occupied the Cape to hunt marine mammals, especially seals. As new beach ridges were formed, camps were made on the ridges closest to the water and, over the centuries, a chronological "horizontal stratigraphy" was laid down in which the oldest cultural remains are found on the fossil-beach ridges farthest from the ocean, with more recent remains and modern camps found on beach ridges closer to the water. The discoveries made at Cape Krusenstern, especially when used in conjunction with those at Onion Portage in Kobuk Valley National Park, provide a definite, datable outline of cultural succession and development in northwest Alaska (USDOI, NPS, 1986a).

III.C.4.b(2) Bering Land Bridge National Preserve. The Bering Land Bridge National Preserve contains archaeological resources that are valuable to the Nation because its record of the past was not disturbed by glaciation (USDOI, NPS, 1986b). The succession of sand dunes at Cape Espenberg may provide information on human migration and habitation similar to the information collected from Cape Krusenstern. The coast north and south of the ancient village of Shishmaref contains numerous sites and some shipwrecks.

III.C.5. Land Use Plans and Coastal Management Program.

III.C.5.a. Land Status and Use.

The North Slope Borough (NSB) is the largest borough in Alaska, with more than 15% of the State's total land area. It lies north of the Arctic Circle, primarily between the north and northeastern coast of Alaska and the Brooks Range. The Borough's land mass encompasses 88,817.1 mi² (ADEC, 2006).

Land-ownership in the Borough is complex. The Federal Government is the predominant land owner, with more than half of the Borough's land area included within the NPR-A and ANWR. Other major landholders include the State of Alaska, Arctic Slope Regional Corporation (ASRC), and eight Native village corporations. Under the terms of the ANCSA, the Native village corporations received only surface-estate rights, whereas ASRC received subsurface-estate rights. Moreover, in ANWR and NPR-A, land selection was restricted to the surface estate for village corporations and the subsurface estate was reserved for the Federal Government. The ASRC was required to select subsurface estate outside these boundaries.

Major land uses on the North Slope are divided between subsistence use and petroleum-resource extraction. Community sociocultural characteristics are more fully covered in Section III.C.3. A discussion of the cumulative effects of oil and gas development in the Borough is found in Section V.A.

III.C.5.b. Land Use Planning Documents.

Guiding the growth and development within the Borough are the NSB Comprehensive Plan and Land Management Regulations (LMR's), and the NSB Coastal Management Program (CMP). The NSBCMP and the Statewide Standards of the Alaska Coastal Management Program (ACMP) are discussed below.

North Slope Borough Comprehensive Plan and Land Management Regulations. The NSB Comprehensive Plan and LMR's were adopted in December 1982 and revised in April 1990. Since then, the Comprehensive Plan underwent further revision in September 2005. The revisions simplified the regulatory process but did not alter the basic premise of the comprehensive plan, which is to preserve and protect the land and water habitat essential to the subsistence character of Inupiat life.

The Borough's LMR's have five zoning districts: Village, Barrow, Conservation, Resource Development, and Transportation Corridor. All areas within the NSB are in the Conservation District, unless they are specifically designated within the limited boundaries of a village or Barrow, a unitized oil field within the Resource Development District, or within the Trans-Alaska Pipeline System (TAPS) corridor. The LMR's categorize uses as:

- a) those that can be administratively approved without public review,
- b) those that require a development permit and public review before they can be administratively approved, and
- c) those considered to be conditional development that must be approved by the Planning Commission.

The LMR's incorporate the policies of the NSBCMP and supplement them with additional policy categories: Village Policies, Economic Development Policies, Offshore Development Policies, and Transportation Corridor Policies. All policies address oil and gas leasing activities, both onshore and offshore. The enforceable policies of the NSBCMP are incorporated within the zoning ordinance in Section 19.70.050.

III.C.5.c. Coastal Zone Management Act.

The Federal Coastal Zone Management Act (CZMA) 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 and the need to protect of valuable coastal resources and

other uses of the coastal area. Each Federal Agency activity within or outside the coastal zone that affects any land or water use or natural resource of the coastal zone must be carried out to be consistent, to the maximum extent practicable, with the enforceable policies of approved State management programs.

The CZMA excludes from the coastal zone "...lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal Government, its officers, or agents" (16 U.S.C. 1453). Although OCS lands are excluded from the coastal zone, all Federal activities occurring on or within the OCS, such as oil and gas lease sales, are subject to consistency review if they have a reasonably foreseeable effect on a coastal use or resource. Federal consistency review provides Alaska with an important tool for managing its coastal uses and resources, and helps ensure sensible oil and gas exploration and development in the coastal area.

III.C.5.c(1) Alaska Coastal Management Program. The ACMP was approved in accordance with the CZMA in 1979. The ACMP includes Statewide standards and coastal district enforceable policies that address development and use of lands and natural resources in the coastal zone. The coastal zone and coastal district boundaries are mapped in the *Biophysical Boundaries of Alaska's Coastal Zone*, an atlas prepared by the Alaska Department of Fish and Game.

The State of Alaska recently amended its ACMP program and adopted new regulations under Title 11, Alaska Administrative Code (AAC), Chapters 110, 112, and 114. The State regulations became effective on October 29, 2004. On December 29, 2005, the USDOC, National Oceanic and Atmospheric Administration, Office of Ocean and Coastal Resource Management (OCRM), completed its review and approved the amendments to the ACMP, finding that the amended ACMP meets all requirements of the CZMA.

Under the amended ACMP, all coastal districts must revise their local plans to conform to the new Statewide standards. Revised district plans needed to be submitted to the State no later than March 1, 2006. A district's existing coastal management program, including its enforceable policies, remains in effect until March 1, 2007, unless the Alaska Department of Natural Resources disapproves or modifies all or part of the program before March 1, 2007. However, any existing district enforceable policy that duplicates, restates, or incorporates by reference a statute or regulation of a Federal or State agency or addresses any matter regulated by the Alaska Department of Environmental Conservation are repealed and declared null and void under State law.

The Statewide standards that may be relevant to activities hypothesized in this EIS are summarized in the following paragraphs under two headings: uses and activities, and resources and habitats.

III.C.5.c(1)(a) Uses and Activities. Under the uses and activities category, the policies that may be relevant to hypothesized activities include: (1) coastal development, (2) natural hazard areas, (3) coastal access, (4) energy facilities, (5) utility routes and facilities, (6) sand and gravel extraction, (7) subsistence, and (8) transportation routes and facilities.

The coastal development standard gives priority to development that is water dependent or water related, and uses that may be neither of these but for which there is no feasible or prudent inland alternative to meet the public need for the use or activity. The intent of the policy is to ensure that onshore development and activities that could be placed inland do not displace activities dependent upon coastal locations.

Natural hazards are defined under 11 AAC 112.990(15) as natural processes or adverse conditions that present a threat to life or property in the coastal areas from flooding, earthquakes, active faults, tsunamis, landslides, volcanoes, storm surges, ice formations, snow avalanches, erosion, and beach processes. Natural hazards also may include other natural processes or adverse conditions designated by the Department of Natural Resources or by a district in a district plan. Natural hazards would be considered during review of individual projects when site-specific information is available. Development plans would need to describe natural hazards in the area, identify site-specific factors that might increase risks, and propose appropriate measures to reduce those risks.

The coastal access standard would require appropriate protection to help maintain the continued desirability of public access to, from, and along coastal waters. Minimizing conflicts between subsistence users and oil and gas activities would be a significant factor for maintaining access and use of the coastal area.

The Statewide energy facilities standard would require that decisions on the siting and approval of energy-related facilities be based, to the extent practicable, on 16 criteria. Practicable as defined in 11 AAC 112.990(18) means feasible in light of overall project purposes after considering cost, existing technology, and logistics of compliance with the standard. The standard also recognizes that the facilities and activities authorized by the issuance of oil and gas leases in a Federal lease sale are uses of State concern.

Utility routes and facilities, unless water dependent or water related, would need to be sited inland to comply with the utility route and facilities standard. Utility routes and facilities along the coast would need to avoid, minimize, or mitigate (1) alterations in surface and ground water drainage patterns; (2) disruption in known or reasonably foreseeable wildlife transit; (3) blockage of existing or traditional access.

Sand and gravel could be extracted from coastal waters, intertidal areas, barrier islands, and spits under the Statewide standard when no feasible and prudent noncoastal alternative is available to meet the public need. Approval to extract sand and gravel from these areas would require a permit from the U.S. Army Corps of Engineers.

The subsistence policy requires the designation of areas in which subsistence is an important use of coastal resources. A Federal OCS project affecting a designated subsistence use area would need to avoid or minimize impacts to subsistence uses. An analysis or evaluation of reasonably foreseeable adverse impacts of the project on subsistence use would also be required.

Transportation routes and facilities would need to avoid, minimize, or mitigate (1) alterations in surface and groundwater-drainage patterns; (2) disruption in known or reasonably foreseeable wildlife transit; and (3) blockage of existing or traditional access.

III.C.5.c(1)(b) Resources and Habitats. Three policy areas come under the heading of resources and habitats: (1) habitats; (2) air, land, and water quality; and (3) historic, prehistoric, and archaeological resources.

Nine coastal habitats are identified in the habitat standards: (1) offshore areas; (2) estuaries; (3) wetlands; (4) tidelands; (5) rocky islands and sea cliffs; (6) barrier islands and lagoons; (7) exposed high-energy coasts; (8) rivers, streams, and lakes; and (9) important uplands. Each habitat must be managed to protect the physical characteristics, use or resource for which the habitat is identified. Mitigation under the habitat standard involves a sequencing process:

- first, to avoid adverse impacts to the maximum extent practicable;
- second, when avoidance is not practicable, to minimize adverse impacts to the maximum extent practicable; and
- third, if neither avoidance nor minimization is practicable, to conduct mitigation to the extent appropriate and practicable.

The ACMP defers to the mandates and expertise of the Alaska Department of Environmental Conservation to protect air, land, and water quality. The standards incorporate the Department's statutes, regulations, and procedures. The Department's standards include, but are not limited to:

- Prevention, control and abatement of any water, land, subsurface land, and air pollution, and other sources or potential sources of pollution of the environment.
- Prevention and control of public health nuisances.
- Safeguard standards for petroleum and natural gas pipeline construction, operation, modification, or alteration.
- Protection of public water supplies by establishing minimum drinking water standards, and standards for the construction, improvement, and maintenance of public water-supply systems.
- Collection and disposal of sewage and industrial waste.
- Collection and disposal of garbage, refuse, and other discarded solid materials from industrial, commercial, agricultural, and community activities or operations.

- Control of pesticides.
- Handling, transportation, treatment, storage, and disposal of hazardous wastes.

The policy addressing historic, prehistoric, and archaeological resources requires the designation of areas of the coastal zone that are important to the study, understanding, or illustration of national, State, or local history or prehistory, including natural processes. A project with a properly designated area would need to comply with the applicable requirements of AS 41.35.010-41.35.240 and 11 AAC 16.010-11 AAC 16.900.

III.C.5.c(2) North Slope Borough District Coastal Management Plan. The Borough adopted its CMP in 1984. Following several revisions, the CMP was approved by the Alaska Coastal Policy Council in April 1985 and by the OCRM in May 1988. The Borough's coastal zone includes all State-owned submerged lands in the Beaufort and Chukchi seas, but because Federal land is excluded from the coastal zone, the Borough's inland coastal zone boundary is divided into two sectors: the mid-Beaufort coastal sector and the Point Hope/Point Lay coastal sector. The mid-Beaufort coastal sector lies between ANWR and NPR-A. The Point Hope/Point Lay coastal sector lies west of NPR-A and north of the Northwest Arctic Borough. In these two sectors, the coastal zone boundary extends inland roughly 25 mi from the coast and along the full length of all major river corridors to include all anadromous fish spawning and overwintering habitats.

All coastal districts, including the NSB, are revising their local plans to conform to the new Statewide standards under the amended ACMP. The NSB's existing coastal management program, including its enforceable policies, will remain in effect until March 1, 2007, unless the Alaska Department of Natural Resources disapproves or modifies all or part of the program before March 1, 2007.

Safeguarding the Inupiat subsistence lifestyle is a high priority for the NSB. To this end, the existing CMP seeks to balance economic development with preservation of and access to the fish and game that support the traditional cultural values and way of life of the Inupiat people. Accordingly, land use on the North Slope under the existing CMP is divided between traditional subsistence uses and the exploration, development, and extraction of mineral resources. The existing CMP contains four categories of policies: (1) standards for development; (2) required features for applicable development; (3) best-effort policies; and (4) minimization of negative impacts. It is anticipated that the NSB's revised district plan will reflect similar safeguards and standards.

The NSB 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 and the Northwest Arctic Boroughs, the area potentially most affected by the Chukchi Sea Sale 193 Lease Sale. Effects on Inupiat Natives could occur because of their reliance on subsistence foods, and exploration and development may affect subsistence resources, subsistence harvest practices, and sociocultural systems.

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 U.S. Environmental Protection Agency (USEPA) 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; USEPA, 2006). Specifically, the Executive Order requires an evaluation in an EIS or EA as to whether the proposed project would have "disproportionately high adverse human health and environmental effects...on minority populations and low income populations."

To determine if the population of these communities would be characterized as minority and low-income populations, the USEPA has defined guidelines for comparing socioeconomic characteristics of the potentially affected communities to a reference population. If the local potentially affected communities have minority or low income characteristics that are higher than the reference population, then they are further evaluated to determine if potential impacts of the proposed project are disproportionately borne by these same local communities (or populations). Because there are no other larger population centers on the North Slope to serve as a reference population, State of Alaska average socioeconomic characteristics were selected as the reasonable reference population. The USEPA guidelines suggest that if a community exhibits ethnic or economic characteristics that are a minimum of 1.2 times the State average for these same characteristics, that the community or local population is considered an Environmental Justice population (USEPA, 1998). The ethnic composition of Barrow, Atkasuk, Wainwright, Point Lay, and Point Hope are shown in Table III.C-15. This table shows that all six communities would be classed as minority communities on the basis of their proportional American Indian and Alaska Native membership. The Statewide population is 15.4% American Indian and Alaskan Native. The communities considered range from 56% in Barrow to 94% in Atkasuk, or from approximately 4-6 times greater minority composition than the State of Alaska as a whole. This ratio is considerably greater than the minimum guideline of 1.2 suggested by the USEPA. On the basis of the much higher percentage of minority composition in these communities than in the state as a whole, an evaluation of disproportionate impacts is required.

Inupiat Natives are the only minority population allowed to conduct subsistence hunts for marine mammals in the region and, in potentially affected Inupiat communities, there are no substantial numbers of "other minorities." Additionally, "other minorities" would not be allowed to participate in subsistence marine mammal hunts and, therefore, would not constitute a potentially affected minority population (NSB, 1999). Low income commonly correlates with Native subsistence-based communities in coastal Alaska; however, subsistence-based communities in the region qualify for Environmental Justice analysis based on their racial/ethnic minority definitions alone (USDOC, Bureau of the Census, 2000, 2002).

The Environmental Justice Executive Order also includes consideration of potential effects to Native subsistence activities and, to this end, MMS continues to maintain a dialogue on Environmental Justice with local communities in this region. The MMS public process for Environmental Justice outreach and for gathering and addressing Environmental Justice concerns and issues is described in detail in the Beaufort Sea multiple-sale final EIS (USDOJ, MMS, 2003a). Since 1999, all MMS public meetings have been conducted under the auspices of Environmental Justice. Environmental Justice-related concerns are taken back to MMS management and incorporated into environmental study planning and design, environmental impact evaluation, and the development of new mitigating measures that are incorporated into the EIS or EA.

Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments*, requires Federal Agencies to consult with Tribal governments on Federal matters that significantly or uniquely affect their communities. In January 2001, a USDOJ Alaska Regional Government-to-Government policy was signed by all the USDOJ Alaska Regional Directors, including the MMS. In acknowledgement of the importance of consultation, the MMS invites tribal governments to participate in its environmental assessment processes.

The Inupiat People of the North Slope and the Northwest Arctic boroughs have made MMS aware of the potential burden of participating in too many planning and public meetings. Therefore, MMS has taken measures to more carefully plan the number and timing of meetings with regional tribal groups and local governments.

On September 14, 2005, MMS published a notice in the *Federal Register* requesting information for proposed Chukchi Sea Lease Sale 193 and providing a Notice of Intent to prepare an Environmental Impact Statement for the proposed sale. The *Federal Register* notice stated that "...the EIS analysis will focus on the potential environmental effects of the sale, exploration, development and production in the areas selected to be considered for leasing. This NOI also serves to announce the initiation of the scoping process for this EIS. Throughout the scoping process, Federal, State, Tribal, and local governments and other interested parties aid MMS in determining the significant issues, potential alternatives, mitigating measures and alternatives to be analyzed in the EIS and the possible need for additional

information...Scoping is intended to solicit input on the scope of the EIS—specifically the issues, alternatives, and mitigation measures....”

Many of these issues were discussed in government-to-government consultation with the ICAS and tribal governments in Barrow, Wainwright, Point Lay, and Point Hope in a North-Slope-wide teleconference on March 9, 2006 and the tribal governments of Barrow on February 2, 2006, and March 6, 2006, Wainwright on March 9, 2006, Point Lay on January 30, 2006, and Point Hope on January 23, 2006. Open public community meetings in Barrow with the NSB (with translation available where requested) were held on December 13, 2004, February 1, 2006, and March 6, 2006, with the NSB Planning and Wildlife Management Departments on February 2, 2006, in Wainwright on March 9, 2006, Point Lay on January 30, 2006, and Point Hope on January 23, 2006. Outreach and information meetings with nongovernment organizations, including the AEWG occurred on December 13, 2004, and March 6, 2006, ICAS on February 2, 2006, the Alaska Beluga Whale Committee on December 6, 2005, and Alaska Walrus Commission on Eskimo Walrus Commission on February 3, 2006. Each meeting included an overview of the activities planned in the area, information on the environmental review for each activity, and identified further opportunities for public participation in the EIS scoping and planning processes. Follow-up NEPA-related training was offered to the communities of Point Lay and Point Hope. The MMS also has participated in a recently initiated series of meetings with the NSB and the Alaska Inter-Tribal Council to discuss ways to incorporate a more systematic appraisal of human health concerns into the EIS process.

In-house activities including Chukchi Sea Science Update during October 2005 (USDO, MMS, 2006a:Appendix F), in which recognized experts made a variety of presentations to MMS staff regarding the physical, biological, and social resources of the Chukchi Sea area.

During public meetings and Government-to-Government meetings, MMS personnel discussed past lease sales, proposed Sales 202 and 193, and other OCS activities including the 5-year draft proposed program process and schedule, the Programmatic Environmental Assessment (PEA) of potential seismic survey activity in the summer of 2006 in the Beaufort Sea and Chukchi seas, and the potential continuation of that activity in 2007. Inupiat translation was provided where needed. These presentations highlighted our desire to receive input on the resources, issues, alternatives, and mitigation measures to be included in the environmental analysis. We emphasized that the EIS is an information document that discloses the potential effects of the Proposed Action and alternatives, including potential mitigation measures to the decision makers, and that no decision regarding the proposed action had been made.

Major Environmental Justice concerns expressed at these meetings include:

- the oil industry’s continuing inability to clean up an oil spill in broken ice;
- the tainting or destroying Native food from oil spills;
- the need to stage cleanup equipment in local communities to make spill response more timely and to give more local people response training;
- the need for larger “Quiet Zone” deferral areas that protect the bowhead whale migration route from seismic sound disturbance; that protect subsistence staging, pursuit, and butchering areas; and that protect critical whale feeding and calving areas;
- the need for impact funds to local communities;
- bowhead whales may be deflected from traditional hunting areas due to increased seismic activity in the Chukchi and Beaufort Seas;
- the effects of seismic noise on beluga whales, walrus, seals, and fish;
- the need to employ monitors and observers from local communities on seismic vessels;
- bowhead whale migration may be deflected from noise caused by small vessels;
- the noise effects of onshore barge traffic and Canadian shipping on bowhead whales;
- the need to expand conflict avoidance agreements to other resources not considered by the AEWG, such as fish, bearded seals, walrus, and beluga whales;
- the need for MMS to coordinate with and include the BLM, NMFS, the Coast Guard, and the State of Alaska in its public outreach process—the need for a multi-agency working group or coordination team;
- the need for MMS, BLM, and the State of Alaska to coordinate their projects, so as to recognize the linkage of onshore and offshore impacts and cumulative impacts;

- the failure to sufficiently recognize Inupiat indigenous knowledge concerning subsistence resources, subsistence-harvest areas, and subsistence practices;
- the failure to provide sufficient baseline data of subsistence species and monitoring of effects;
- that multiple industrial operations may have a cumulative adverse impact on the bowhead whale migration;
- that increased industrial noise levels in the Beaufort and Chukchi Seas will force hunters to travel farther to find whales and that this may lead to reduced success and an increased struck and lost rate for hunters that may, in turn, cause the IWC to reduce the bowhead whale quota because of potential reduced hunting efficiency;
- the need for MMS to revise its significance thresholds for subsistence and sociocultural systems and bring them in line with the MMPA's "no unmitigable adverse impact" definition;
- further analysis of effects on offshore bowhead whale feeding areas;
- the need to pursue an Memorandum of Understanding with the NSB to ensure that their "Seven Points" concerns are addressed by MMS;
- the need for MMS to deal with potential impacts by instituting stronger mitigation measures and adopting bigger deferral areas;
- include a cumulative effects analysis that addresses the recommendations of the 2003 National Research Council (NRC) Report *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope*;
- the need to reconsider the multiple-sale concept--because of a quickly changing Arctic environment and increasing oil and gas activity--and instead prepare a Supplemental EIS instead of an EA for each lease sale;
- the "disconnect" between MMS and the residents of the North Slope on how lease-sale decisions are made;
- the need for an Barrow-based MMS/BLM office;
- the effects of toxins and contaminants in the Arctic environment on subsistence foods;
- the damaging of Inupiat culture from effects to subsistence and stress and anxiety from the threat of possible development activities;
- the effects of global climate change on ice conditions, subsistence resources and subsistence-harvesting practices in the Alaskan Arctic;
- the increasing distance needed to travel to hunt as the ice edge retreats; and
- the need for a Presidential withdrawal on lease sales in the Beaufort and Chukchi Seas until controversial issues are satisfactorily addressed.

These issues are addressed in Section IV.C.1.p, Effects on Environmental Justice, of this EIS.

SECTION IV

ENVIRONMENTAL CONSEQUENCES

Contents of Section IV

IV. ENVIRONMENTAL CONSEQUENCES IV-1

IV.A. Basic Assumptions for Effects Assessment, IV-1

- IV.A.1. Significance Thresholds IV-2
- IV.A.2. Exploration and Development Scenarios IV-4
- IV.A.3. Disturbances IV-13
- IV.A.4. Oil Spills IV-18
- IV.A.5. Spill Prevention and Response IV-21

IV.B. Alternative II – No Lease Sale IV-23

- IV.B.1. Effects of Alternative II IV-23
- IV.B.2. Possible Substitutes for Delayed or Lost Oil and Gas Production IV-24
- IV.B.3. Environmental Impacts from the Most Important Substitutes IV-25

IV.C. Analysis of Effects of Chukchi Sea Oil and Gas Development IV-26

IV.C.1. Alternative I – Proposed Action IV-26

IV.C.1.a. Water Quality IV-26

- IV.C.1.a(1) Existing Water Quality IV-26
- IV.C.1.a(2) Water Quality Criteria IV-26
- IV.C.1.a(3) Impacts Relating to Oil and Gas Postlease Activities IV-27
- IV.C.1.a(4) Discharges IV-28
- IV.C.1.a(5) Regulatory Protection of Water Quality IV-32
- IV.C.1.a(6) Oil Spills IV-33
- IV.C.1.a(7) Effects from 3D Seismic Surveys IV-36
- IV.C.1.a(8) Effects from Exploration Activities IV-36
- IV.C.1.a(9) Effects from Development Activities IV-37
- IV.C.1.a(10) Effects of Mitigation Measures IV-37

IV.C.1.b. Air Quality, IV-38

- IV.C.1.b(1) Effects Common to All Alternatives IV-40
- IV.C.1.b(2) Oil Spills IV-42
- IV.C.1.b(3) Other Effects on Air Quality IV-44
- IV.C.1.b(4) Community Views on Air Emissions IV-44

IV.C.1.c. Lower Trophic-Level Organisms IV-45

- IV.C.1.c(1) Conclusion IV-45
- IV.C.1.c(2) Effects from 3D/2D Seismic Surveys IV-46
- IV.C.1.c(3) Effects from Exploration IV-46
- IV.C.1.c(4) Effects from Development Projects IV-47
- IV.C.1.c(5) Effectiveness of Proposed Mitigation Measures IV-51

IV.C.1.d. Fish Resources IV-51

- IV.C.1.d(1) Summary IV-51
- IV.C.1.d(2) Potential Effects from 3D Seismic Surveys IV-52
- IV.C.1.d(3) Effects from Exploration and Development IV-56
- IV.C.1.d(4) Large Oil Spill from a Pipeline or a Production Platform IV-70
- IV.C.1.d(5) Chronic Small-Volume Spills IV-72
- IV.C.1.d(6) Effects from a Spill during Seismic Activities IV-72
- IV.C.1.d(7) Effects from Oil-Spill Response IV-72
- IV.C.1.d(8) Mitigation Measures IV-73
- IV.C.1.d(9) Conclusion IV-74

IV.C.1.e. Essential Fish Habitat IV-75

- IV.C.1.e(1) Summary IV-75
- IV.C.1.e(2) Potential Effects from 3D Seismic Surveys on Essential Fish Habitat IV-75
- IV.C.1.e(3) Potential Effects from Exploration and Development on Essential Fish Habitat IV-75
- IV.C.1.e(4) Potential Effects of a Large Oil Spill on Essential Fish Habitat IV-
- IV.C.1.e(5) Potential Effects from Oil-Spill Response IV-78
- IV.C.1.e(6) Mitigation Measures IV-78
- IV.C.1.e(7) Anticipated Impacts from the Proposed Action on Essential Fish Habitat IV-79

- IV.C.1.f. Threatened and Endangered Species IV-80**
 - IV.C.1.f(1) Threatened and Endangered Marine Mammals **IV-80**
 - IV.C.1.f(1)(a) Principles and Assumptions Underlying Analyses of Potential Effects **IV-81**
 - IV.C.1.f(1)(b) Potential Impacts from the Proposed Action Scenario **IV-84**
 - IV.C.1.f(1)(c) Potential Effects of Noise and Disturbances on Cetaceans **IV-84**
 - IV.C.1.f(1)(d) Potential Effects from Seismic Surveys **IV-90**
 - IV.C.1.f(1)(e) Conclusions **IV-104**
 - IV.C.1.f(1)(f) Discharge of Drilling Wastes **IV-114**
 - IV.C.1.f(1)(g) Large Crude Oil Spills **IV-114**
 - IV.C.1.f(1)(h) Mitigation Measures **IV-122**
 - IV.C.1.f(2) Threatened and Endangered Species – Marine and Coastal Birds **IV-125**
- IV.C.1.g. Marine and Coastal Birds **IV-125**
 - IV.C.1.g(1) Summary **IV-125**
 - IV.C.1.g(2) Potential Effects of Seismic Surveys on Marine and Coastal Birds **IV-126**
 - IV.C.1.g(3) Potential Effects of Exploration and Production on Marine and Coastal Birds **IV-129**
 - IV.C.1.g(4) Probabilities of Contacting Spilled Oil **IV-134**
 - IV.C.1.g(5) Mitigation Measures **IV-137**
 - IV.C.1.g(6) Anticipated Impacts of the Proposed Action to Marine and Coastal Birds **IV-138**
- IV.C.1.h. Other Marine Mammals **IV-145**
 - IV.C.1.h(1) Conclusions **IV-145**
 - IV.C.1.h(2) Effects from 2D/3D Seismic Surveys **IV-152**
 - IV.C.1.h(3) Effects from Exploration and Development **IV-152**
 - IV.C.1.h(4) Effects from Oil Spills **IV-156**
 - IV.C.1.h(5) Effectiveness of Mitigation Measures **IV-162**
 - IV.C.1.h(6) Marine Fissipeds – Polar Bear **IV-163**
 - IV.C.1.h(7) Benefits of the Standard Mitigation **IV-168**
 - IV.C.1.h(8) Effectiveness of Mitigation Measures **IV-169**
- IV.C.1.i. Terrestrial Mammals **IV-172**
 - IV.C.1.i(1) Conclusions, **IV-172**
 - IV.C.1.i(2) Effects from 2D/3D Seismic Surveys **IV-172**
 - IV.C.1.i(3) Effects from Exploration and Development **IV-172**
 - IV.C.1.i(4) Effects from Development and Production **IV-175**
 - IV.C.1.i(5) Effectiveness of Mitigation Measures **IV-178**
- IV.C.1.j. Vegetation and Wetlands **IV-178**
 - IV.C.1.j(1) Conclusions **IV-179**
 - IV.C.1.j(2) Effects from 3D Seismic Surveys **IV-179**
 - IV.C.1.j(3) Effects from Exploration Activities **IV-179**
 - IV.C.1.j(4) Effects from Development Activities **IV-179**
 - IV.C.1.j(5) Effectiveness of Mitigation Measures **IV-182**
- IV.C.1.k. Economy **IV-182**
 - IV.C.1.k(1) Revenues and Expenditures **IV-183**
 - IV.C.1.k(2) Stipulations and Information to Lessees **IV-185**
- IV.C.1.l. Subsistence-Harvest Patterns **IV-185**
 - IV.C.1.l(1) Effects from Routine Operations **IV-181**
 - IV.C.1.l(1)(a) Effects from Discharges, Seismic Surveys, Noise, Disturbances, and Small Oil Spills **IV-187**
 - IV.C.1.l(1)(a)1 Effects from Discharges **IV-187**
 - IV.C.1.l(1)(a)2 Effects from Seismic Surveys **IV-188**
 - IV.C.1.l(1)(a)3 Effects from Other Noise and Disturbance **IV-190**
 - IV.C.1.l(1)(a)4 Effects from Other Noise and Disturbance on Subsistence Resources **IV-191**
 - IV.C.1.l(1)(a)5 Effects from Small Oil Spills **IV-197**
 - IV.C.1.l(1)(a)6 Traditional Knowledge on Effects from Discharges, Seismic Surveys, Noise, Disturbances, and Small Oil Spills **IV-199**
 - IV.C.1.l(1)(b) Effects from Large Oil Spills **IV-211**
 - IV.C.1.l(1)(b)1 Conditional Probabilities **IV-212**
 - IV.C.1.l(1)(b)2 Combined Probabilities **IV-216**
 - IV.C.1.l(1)(b)3 Effects from a Large Spill on Subsistence Resources **IV-216**

IV.C.1.l(1)(b)4	Subsistence Practices	IV-218
IV.C.1.l(1)(b)5	Effects from Cleanup Activities on Subsistence Resources	IV-219
IV.C.1.l(1)(b)6	Traditional Knowledge on Effects from a Large Oil Spill and Cleanup	IV-221
IV.C.1.l(2)	Effectiveness of Mitigation Measures	IV-223
IV.C.1.l(2)(a)	Standard Mitigation	IV-223
IV.C.1.l(2)(b)	Mitigation Specific to Seismic Surveying	IV-224
IV.C.1.l(2)(b)1	Standard MMS G&G Permit Stipulations	IV-227
IV.C.1.l(2)(b)2	Measures to Mitigate Seismic Exposure to Subsistence Resources and Practices	IV-228
IV.C.1.l(2)(c)	Alternative Mitigation for Seismic Surveying	IV-229
IV.C.1.l(2)(d)	Transboundary Effects and Mitigation	IV-231
IV.C.1.m.	Sociocultural Systems	IV-233
IV.C.1.m(1)	Conclusions	IV-234
IV.C.1.m(2)	Effects from 2D/3D Seismic Surveys	IV-235
IV.C.1.m(3)	Effects from Exploration	IV-235
IV.C.1.m(4)	Effects from Development and Production	IV-235
IV.C.1.m(4)(a)	Effects from Routine Activities	IV-235
IV.C.1.m(4)(b)	Effects from a Large Oil Spill	IV-237
IV.C.1.m(5)	Effectiveness of Mitigation Measures	IV-239
IV.C.1.m(5)(a)	3D Seismic Surveys	IV-239
IV.C.1.m(5)(b)	Sale 193 Stipulations and ITL's	IV-239
IV.C.1.m(5)(c)	Other Mitigation	IV-239
IV.C.1.n.	Archaeological Resources	IV-240
IV.C.1.n(1)	Effects from Exploration	IV-240
IV.C.1.n(1)(a)	Effects from Routine Operations – Disturbance	IV-241
IV.C.1.n(1)(b)	Effects from Small Oil Spills	IV-241
IV.C.1.n(2)	Effects from Development and Production	IV-241
IV.C.1.n(2)(a)	Effects from Routine Operations – Disturbance	IV-241
IV.C.1.n(2)(b)	Effects from Small Oil Spills	IV-242
IV.C.1.n(2)(c)	Effects from a Large Oil Spill	IV-242
IV.C.1.o.	Land Use Plans and Coastal Management Programs	IV-242
IV.C.1.o(1)	North Slope Borough Comprehensive Plan and Land Management Regulations	IV-243
IV.C.1.o(2)	Alaska Coastal Management Program (ACMP)	IV-244
IV.C.1.p.	Environmental Justice	IV-253
IV.C.1.p(1)	Overview	IV-253
IV.C.1.p(2)	Demographics	IV-254
IV.C.1.p(2)(a)	Race	IV-254
IV.C.1.p(2)(b)	Income	IV-254
IV.C.1.p(2)(c)	Consumption of Fish and Game	IV-254
IV.C.1.p(2)(d)	Health Status	IV-255
IV.C.1.p(3)	Impact Assessment Overview	IV-259
IV.C.1.p(4)	Potential Effects on Health Status	IV-260
IV.C.1.p(5)	Standard, Potential, and Ongoing Studies and Mitigation Initiatives	IV-264
IV.C.2.	Alternative III (Corridor I Deferral)	IV-267
IV.C.2.a.	Water Quality	IV-267
IV.C.2.b.	Air Quality	IV-267
IV.C.2.c.	Lower Trophic-Level Organisms	IV-267
IV.C.2.d.	Fish Resources	IV-268
IV.C.2.e.	Essential Fish Habitat	IV-268
IV.C.2.f.	Threatened and Endangered Species	IV-268
IV.C.2.f(1)	Threatened and Endangered Marine Mammals	IV-268
IV.C.2.f(2)	Threatened and Endangered Marine and Coastal Birds	IV-269
IV.C.2.g.	Marine and Coastal Birds	IV-269
IV.C.2.h.	Other Marine Mammals	IV-269
IV.C.2.i.	Terrestrial Mammals	IV-269
IV.C.2.j.	Vegetation and Wetlands	IV-269
IV.C.2.k.	Economy	IV-269
IV.C.2.l.	Subsistence-Harvest Patterns	IV-270

- IV.C.2.m. Sociocultural Systems **IV-270**
- IV.C.2.n. Archaeological Resources **IV-271**
- IV.C.2.o. Land Use Plans and Coastal Management Programs **IV-271**
- IV.C.2.p. Environmental Justice **IV-271**
- IV.C.3. Alternative IV (Corridor II Deferral) – Agency-Preferred Alternative **IV-271****
 - IV.C.2.a. Water Quality **IV-271**
 - IV.C.2.b. Air Quality **IV-272**
 - IV.C.2.c. Lower Trophic-Level Organisms **IV-272**
 - IV.C.2.d. Fish Resources **IV-272**
 - IV.C.2.e. Essential Fish Habitat **IV-272**
 - IV.C.2.f. Threatened and Endangered Species **IV-273**
 - IV.C.2.f(1) Threatened and Endangered Marine Mammals **IV-273**
 - IV.C.2.f(2)Threatened and Endangered Marine and Coastal Birds **IV-273**
 - IV.C.2.g. Marine and Coastal Birds **IV-274**
 - IV.C.2.h. Other Marine Mammals **IV-274**
 - IV.C.2.i. Terrestrial Mammals **IV-274**
 - IV.C.2.j. Vegetation and Wetlands **IV-274**
 - IV.C.2.k. Economy **IV-274**
 - IV.C.2.l. Subsistence-Harvest Patterns **IV-274**
 - IV.C.2.m. Sociocultural Systems **IV-275**
 - IV.C.2.n. Archaeological Resources **IV-275**
 - IV.C.2.o. Land Use Plans and Coastal Management Programs **IV-276**
 - IV.C.2.p. Environmental Justice **IV-276**
- IV.C.4. Alternative A ((Exploration Seismic Surveys within the Entire Proposed Sale 193 Area) **IV-276****
- IV.C.5. Alternative B (Prohibit Pre-Sale 193 Exploration Seismic Surveys in the Corridor II Deferral Area) **IV-276****
- IV.D. Unavoidable Adverse Effects **IV-277****
 - IV.D.1. Water Quality **IV-277**
 - IV.D.2. Air Quality **IV-278**
 - IV.D.3. Lower Tropic-Level Organisms **IV-278**
 - IV.D.4. Fish Resources **IV-278**
 - IV.D.5. Essential Fish Habitat **IV-278**
 - IV.D.6. Threatened and Endangered Species **IV-278**
 - IV.D.6.a. Threatened and Endangered Marine Mammals **IV-278**
 - IV.D.6.b. Threatened and Endangered Marine and Coastal Birds **IV-279**
 - IV.D.7. Marine and Coastal Birds **IV-279**
 - IV.D.8. Other Marine Mammals **IV-279**
 - IV.D.9. Terrestrial Mammals **IV-279**
 - IV.D.10. Vegetation and Wetlands **IV-280**
 - IV.D.11. Economy **IV-280**
 - IV.D.12. Subsistence-Harvest Patterns **IV-280**
 - IV.D.13. Sociocultural Systems **IV-280**
 - IV.D.14. Archaeological Resources **IV-280**
 - IV.D.15. Land Use Plans and Coastal Management Programs **IV-280**
 - IV.D.16. Environmental Justice **IV-281**
- IV.E. Relationship Between Local Short-Term Uses and Maintenance and Enhancement of Long-Term Productivity **IV-281****
 - IV.D.1. Water Quality **IV-281**
 - IV.D.2. Air Quality **IV-281**
 - IV.D.3. Lower Tropic-Level Organisms **IV-282**
 - IV.D.4. Fish Resources **IV-282**
 - IV.D.5. Essential Fish Habitat **IV-282**
 - IV.D.6. Threatened and Endangered Species **IV-282**
 - IV.D.6.a. Threatened and Endangered Marine Mammals **IV-282**
 - IV.D.6.b. Threatened and Endangered Marine and Coastal Birds **IV-282**
 - IV.D.7. Marine and Coastal Birds **IV-283**

- IV.D.8. Other Marine Mammals **IV-283**
 - IV.D.9. Terrestrial Mammals **IV-283**
 - IV.D.10. Vegetation and Wetlands **IV-283**
 - IV.D.11. Economy **IV-283**
 - IV.D.12. Subsistence-Harvest Patterns **IV-284**
 - IV.D.13. Sociocultural Systems **IV-284**
 - IV.D.14. Archaeological Resources **IV-284**
 - IV.D.15. Land Use Plans and Coastal Management Programs **IV-284**
 - IV.D.16. Environmental Justice **IV-284**
- IV.F. Irreversible and Irretrievable Commitment of Resources **IV-284****
- IV.D.1. Water Quality **IV-284**
 - IV.D.2. Air Quality **IV-285**
 - IV.D.3. Lower Tropic-Level Organisms **IV-285**
 - IV.D.4. Fish Resources **IV-285**
 - IV.D.5. Essential Fish Habitat **IV-285**
 - IV.D.6. Threatened and Endangered Species **IV-285**
 - IV.D.6.a. Threatened and Endangered Marine Mammals **IV-285**
 - IV.D.6.b. Threatened and Endangered Marine and Coastal Birds **IV-285**
 - IV.D.7. Marine and Coastal Birds **IV-286**
 - IV.D.8. Other Marine Mammals **IV-286**
 - IV.D.9. Terrestrial Mammals **IV-286**
 - IV.D.10. Vegetation and Wetlands **IV-286**
 - IV.D.11. Economy **IV-286**
 - IV.D.12. Subsistence-Harvest Patterns **IV-286**
 - IV.D.13. Sociocultural Systems **IV-286**
 - IV.D.14. Archaeological Resources **IV-286**
 - IV.D.15. Land Use Plans and Coastal Management Programs **IV-286**
 - IV.D.16. Environmental Justice **IV-287**

IV. ENVIRONMENTAL CONSEQUENCES.

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 Proposed Action (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 hypothetical field-development assumptions called a scenario. The MMS traditionally bases the EIS scenarios on geologic potential, industry trends, and available technology. While no development has occurred in this area after two lease sales and limited exploration activity, we assume that the next lease sale will result in an oil field that is leased, discovered, developed, and produced in the sale area under consideration. This section details the scientific, economic, geologic, and other assumptions on which the exploration, development, and transportation scenarios in this EIS are based.

The location of any commercial oil accumulation is purely hypothetical until oil is proven by drilling. While the EIS 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 as the price of oil, the availability of competing oil-production areas, and company perspectives about Alaska. If commercial quantities of oil are discovered in the Chukchi Sea OCS and development occurs at a location where the infrastructure also could be used to support production of fields in the western Beaufort Sea, then the development in the Chukchi Sea Planning Area could have a synergistic effect on the level of OCS activity in the adjacent Beaufort Sea. Such a synergistic effect under the cumulative case is considered to be very speculative at this time (Sec. V.B).

The remainder of this section evaluates the potential effects of the Proposed Action and the alternatives. The information in this section is presented by alternative; the analysis under each alternative is presented by resource. In many cases, the estimated effects to specific resource are identical or similar under two or more of the alternatives. In such cases, rather than repeat the analysis, we reference the analysis already described.

To help focus, we provide only the information that will help the reader and decisionmaker focus on the differences among the alternatives.

Each analysis of effects in this EIS evaluates the following key resource topics that were identified during scoping:

- Water Quality
- Air 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
- Environmental Justice

If leasing takes place, we can reasonably project that potential impacts could occur from the following exploration activities:

- noise from seismic surveys, aircraft, and marine support boats and traffic from seismic-survey vessels and aircraft;
- discharge of well-drilling fluids and domestic wastewater from the exploration wells;
- 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;
- marine vessels and aircraft traffic; and
- physical emplacement, presence, and movement of exploration rigs.

If exploration leads to commercial development, potential impacts could occur from the following:

- noise from construction of overland roads, pipeline installation, construction of onshore facilities;
- marine and aircraft 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 vessels and aircraft; and
- physical placement, presence, and removal of offshore production facilities and pipelines.

Other possible activities could include: (1) large oil-spill accidents (blowouts, production accidents, pipeline leaks or ruptures, and fuel spills) with associated impacts directly from the spill and indirect impacts from spill-cleanup activities; and (2) other industrial accidents involving the facilities (explosions, fires, vessel sinking, etc.).

For purposes of analysis, we assume that a large oil field will be developed. The reader and decisionmaker(s) should consider the 60% chance of no large oil spills occurring over the life of the project when considering the spill and cleanup effects. Even though the conditional analysis assumes that a large oil spill occurs and provides estimates of a large oil spill contacting a specific environmental resource area or land segment, the reader should remember that the chance of one or more oil spills, greater than or equal to (\geq) 1,000 barrels (bbl), occurring from the proposed lease sale and contacting any environmental resource area ranges from less than ($<$) 0.5-7% within 30 days over the life of the project (Appendix A, Table A.2-75). All exploration and production activities require an approved oil-spill-response plan and, if an oil spill occurred, oil-containment and -cleanup activities could begin within hours or minutes of the detection of a spill, if the weather allowed. This response could minimize the chance of long-term impacts from accidental oil spills.

Sections IV.D, IV.E, IV.F, and V are common to all alternatives for Sale 193 and are analyzed by resource category. These include the following topics, respectively:

- Unavoidable Adverse Effects;
- Relationship Between Local-Short-Term Uses and Maintenance and Enhancement of Long-Term Productivity;
- Irreversible and Irrecoverable Commitment of Resources;
- Comparison of the Effects of the Alternatives and the Cumulative Effects

IV.A.1. Significance Thresholds.

The Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations (40 Code of Federal Regulations (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 analyses in this EIS use 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 analyses in this EIS also consider 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 CEQ 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 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 (e.g., implementation of the oil-spill-response plan). For example, for an endangered species, the analysis considers the possible effects of a large oil spill in terms of the following:

- lethal and sublethal 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 the oil contacting the species.

For impacts on water quality from construction disturbance, the analysis considers the following:

- the increases in suspended particles and turbidity relative to water-quality criteria;
- the 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 of short-term 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 are considered “not significant.”

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:

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 (USEPA) criterion more than once in a 1-year period and averages more than the chronic State Standard or USEPA criterion over 25 square kilometers (km²) for a month. The spillage of crude or refined oil in which the total aqueous hydrocarbons in the water column exceeds 1.5 parts per million (ppm), the assumed acute (toxic) criteria, for more than 3 days over at least 10 km² and 15 parts per billion (ppb), the assumed chronic criteria and the State of Alaska ambient-water-quality standard, for more than a month over 25 km². An increase in anthropogenic contaminants in regional sediments to levels that have resulted in adverse biological effects in 10% of tested organisms (Effects Range-Low; Long et al., 1995; Long, Field, and Macdonald, 1998). 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. However, an action of violation or accidental discharge of a small volume of 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 (PSD) criteria or the National Ambient Air Quality Standards (NAAQS) for nitrogen dioxide, sulfur dioxide, or

particulate matter <10 microns (μ) in diameter; or exceeds half the increase permitted under the NAAQS for carbon monoxide or ozone.

Biological Resources (seals, walrus, beluga whale, marine and coastal birds, terrestrial mammals, lower trophic-level organisms, fishes, essential fish habitat, vegetation and wetlands, and polar bears): 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; one or more generations for polar bears.

Threatened and Endangered Species: An adverse impact that results in a decline in abundance and/or change in distribution requiring one or more generations for the indicated population to recover to its former status. For declining populations, any take identified during the Section 7 consultation process would constitute a significant impact.

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.

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 that occurs for a period of 2-5 years with a tendency toward the displacement of existing social patterns.

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.

Archaeological Resources and Cultural Resources: An interaction between an archaeological site and an effect-producing factor occurs and results in the loss of unique, archaeological information. National and State Parks and Other Special Areas: The intrinsic values of the unit are affected for a period of 2-5 years.

Coastal Zone Management: Any activities resulting in reasonably foreseeable effects that may conflict with land use plans and enforceable policies of applicable coastal management programs and cannot be addressed by the mitigation assumed for the Proposed Action or by existing regulatory requirements.

IV.A.2. Exploration and Development Scenarios.

In this section, we describe scenarios for petroleum activities in the Chukchi Sea leasing area. Scenarios are conceptual views of the future and represent possible, though not necessarily probable, sets of activities. To develop the scenarios we consider the petroleum-resource potential of the area, the technology to explore and produce oil and gas from the offshore area, and industry trends in northern Alaska. The scenarios are generated using professional judgment, not rigorous statistical data, because the size and location of oil and gas pools are unknown at the present time and we have no direct knowledge of future industry strategies. The timing of exploration and development activities and volume of petroleum ultimately produced as a result of the next lease sale in the Chukchi OCS is impossible to predict with any certainty. However, the assumed scenario provides a common basis for the analysis of potential environmental impacts, should future activities occur similar to those postulated here.

Although all scenarios are hypothetical and, therefore, uncertain, they can be categorized as *reasonably foreseeable* and *speculative*. Reasonably foreseeable scenarios are viewed as extensions of current trends that are more likely to occur within a decade or two. For this EIS, we consider oil production from the Chukchi shelf as reasonably foreseeable, because the area has high oil-resource potential and there is

existing transportation infrastructure to move oil from northern Alaska to distant markets. Conversely, we consider offshore gas production to be speculative for the current Chukchi leasing program, because although the area has a high potential for natural gas occurrence, there is no existing transportation infrastructure to move produced gas to markets.

Natural gas has been produced in low quantities (0.7 billion cubic feet per year [Bcf/yr]) for local use in the village of Barrow since the mid-1940's and in high quantities (8 Bcf/day) from Prudhoe Bay area fields since 1969. Associated gas produced from North Slope oil fields has been reinjected to increase oil recovery and also used for fuel in facilities. It is estimated that approximately 35 trillion cubic feet (Tcf) of natural gas is contained in known accumulations and another 200 Tcf could occur in undiscovered pools throughout northern Alaska (U.S. Geological Survey, 2005). A discussion of the regional petroleum geology of the Chukchi Sea Planning Area can be found on the MMS Alaska Region website at <http://www.mms.gov/alaska/re/reports/2006Asmt/ga.HTM>.

Natural gas in northern Alaska is described as "stranded" until a gas-transportation system to outside markets is constructed. At the present time, a large-diameter gas pipeline seems to be the most likely project for that purpose. For a variety of reasons, MMS considers such a gas pipeline to be speculative at this time. While various gas pipeline projects are being discussed for sometime in the future, there is no specific proposal being considered at this time. There is uncertainty about the route of such a pipeline, how and when it might be constructed, how long it would be until it might be operational, what the design capacity might be, etc.. Most of the "standard indicators" that a future action is reasonably foreseeable have not occurred in relation to a gas pipeline, including a development of a specific proposal, applications for permits, and a Notice of Intent to Prepare an EIS. Until a gas-transportation system is constructed and operational and has available capacity to transport gas from other than Prudhoe Bay and nearby fields, it is unrealistic to assume that natural gas would be economic to produce from the Chukchi Sea program area. Therefore, gas production is not included in the scenario for the Proposed Action.

Development scenarios are strongly influenced by the petroleum resource characteristics of the area. Although we cannot accurately define where large pools will be discovered in the future, it is more likely that commercial development will occur in areas with larger numbers of large pools. Large prospects are more easily identified and are attractive to industry because they are more likely to be economically viable to develop if discoveries are made. Periodically, the geology of the OCS program areas is analyzed and estimates for recoverable petroleum are summarized in resource assessments.

The most recent petroleum assessment for the Chukchi was completed in 2006 (<http://www.mms.gov/alaska/re/reports/2006Asmt/CHGA/chga.HTM>). The Chukchi OCS is very rich in both oil and gas potential, with mean technically recoverable resources of 15.4 billion barrels of oil (Bbbl) and 76.8 trillion cubic feet of gas (Tcfg). However, the very high costs of all operations cause most of this resource endowment to be sub-economic, even at high oil and gas prices. At a \$60 oil price, 8.4 Bbbl of oil (55% of total recoverable oil) could be economic to develop, if discovered. However, 5 exploration wells have already tested some of the largest prospects without making a commercial-size oil discovery.

Future oil production from the Chukchi Sea will depend on many factors, including the access to prime areas for exploration and sustained high oil prices, which will attract industry investments to this remote, high-cost location. Offshore petroleum development in the Chukchi OCS will face a number of logistical and regulatory hurdles. These hurdles could negatively impact industry activities to convert undiscovered resources to producing reserves. Although theoretically present and potentially viable, all of the estimated economic resources will not be developed in a foreseeable timeframe, because exploration effort is likely to target only the largest prospects. Marginal discoveries probably would not be developed, because the risk of economic failure is too high. This means that future production from this frontier area is unlikely to ever reach the full economic potential as estimated by petroleum-resource assessments).

No permanent petroleum infrastructure exists in this remote area; therefore, a realistic scenario includes only the discovery, development, and production of the first offshore project. When the first project overcomes the cost, logistical, and regulatory hurdles, more projects are more likely to follow. If the challenges are not overcome, the area will remain undeveloped. As typical of many frontier areas, development usually starts with a relatively large project that supports the cost of initial infrastructure.

Progressively smaller fields are developed after using this infrastructure, and the industrial footprint expands away from the core area.

A scenario that assumes any offshore oil development in the Chukchi OCS represents an abrupt increase in the level of activity compared to the past. There have been no lease sales and virtually no petroleum exploration in the Chukchi Sea since 1991. Four lease sales were held on different parts of the Chukchi shelf between 1988 and 1991, but only a small fraction of the tracts were leased by industry (483 leases, or approximately 5% of those offered). Five exploration wells drilled in 1989-1991 tested five large prospects, none of which resulted in commercial-size discoveries. There have been no active leases in the Chukchi Sea since 1998.

Future leasing and exploration interest in the Chukchi will be supported by high oil prices and advancements in exploration and production technology. High prices and new technology are both vital in overcoming the challenges of this difficult setting. The Chukchi OCS is viewed as one of the most petroleum-rich offshore provinces in the country, with geologic plays extending offshore from some of the largest oil and gas fields in North America on Alaska's North Slope. Our current petroleum assessment indicates that the mean recoverable oil resource is 12 Bbbl with a 5% chance of 29 Bbbl. Most government and industry analysts agree that this province could hold large oil fields comparable to any frontier area in the world. It is reasonable to assume that exploration of this area could lead to significant oil discoveries. The uncertainty is whether offshore development will follow successful exploration. In a frontier area, this is not a solid assumption. However, for purposes of analysis we assume that one large oil field will be developed as a result of the next Chukchi lease sale.

IV.A.2.a. Chukchi Sea Sale 193 Scenario.

The following scenario assumes active leasing and exploration by industry followed by development that is unhindered by long regulatory delays. Estimates for infrastructure are given in Table IV.A-1, and a possible schedule for the scenario is given in Table IV.A-2a.

The scale of future activities will be controlled largely by industry perceptions of the Chukchi program area relative to other worldwide exploration opportunities. Industry decisions primarily are influenced by their opinions regarding the petroleum potential, future market prices, and the regulatory regime. Individual companies could have widely varying views of these factors, and these views could change (positive or negative) through time. As stated previously, the scenario represents a possible set of circumstances, but the specific location and scale of offshore development will not be known for decades.

The scenario assumed for environmental analysis assumes the discovery, development, and production of the first offshore oil field in the Chukchi Sea. Ultimately recoverable oil resources from this field are assumed to be 1 Bbbl, as lower oil volumes are not likely to be economic. If oil prices drop below \$30.00 per barrel (they were above \$50.00 when this scenario was written), exploration in the Chukchi OCS is expected to be minimal and oil discoveries may not be developed. The "exploration only" scenario represents the status quo in this area, where discoveries are too small or costly for commercial development. As previously discussed, offshore natural gas discoveries are not likely to be developed until a gas transportation system from the North Slope to outside markets is operational and has capacity to accept additional gas supplies from new fields. Other gas transportation strategies (liquefied natural gas [LNG]) were not considered to be as feasible or economically attractive as an overland pipeline system to U.S. markets.

Changes in Potential for Development for the Alternatives. Petroleum-resource assessments of the Chukchi Sea Sale 193 area give a broad view of the potential for future commercial development. The assessments are based on geologic and engineering analysis assuming that the entire area is open to leasing; industry will completely explore the area in a very short timeframe (<20 years); regulations will not inhibit industry activities; and all economically viable resources will be developed, even if they are only marginally profitable. These obviously are unrealistic assumptions and, therefore, future development is more likely to be at a lesser scale and over a longer time period than suggested by economically recoverable resource estimates. This is why we used the concept for discovery/development of the first offshore oil field (1 Bbbl) for purposes of environmental analysis. A more realistic prediction would be for

a continuation of exploration activities only in this frontier area. However, a thorough NEPA analysis requires consideration of the potential for impacts associated with offshore development, should it occur.

As part of the analysis, we must analyze the potential impacts associated with different leasing alternatives. Generally, these alternatives constitute leasing restrictions in different parts of the program area. It is not possible to accurately define where the first commercial development will occur because the locations cannot be determined without drilling (after leasing), and we cannot predict industry strategies to lease and drill specific tracts. In a typical frontier area a simple concept often holds true—area equals opportunity. Removing areas from leasing will eliminate the chance that commercial development will occur in that particular area. In one sense, deferring an area could redirect exploration effort into remaining open areas. However, considering the area as a whole, restricting access limits the opportunities for successful exploration, which could lead to commercial development.

Table IV.A-3 lists scaling factors described as the Opportunity Index. The opportunity index represents our estimate of the chance that commercial fields will be leased, drilled, discovered, and developed in these areas—assuming that 1 commercial development will occur as a result of Sale 193. As previously discussed, there is a rather low probability for commercial success in any frontier area, particularly a challenging area such as the Chukchi Sea. A realistic probability for commercial success is likely to be <10%. This analysis reflects the current data and knowledge of MMS. Industry groups could have a much different view of the oil potential in various parts of the Chukchi Sea. These estimates do not include the effects of restrictions to activities in the deferral areas (transportation, pipelines, etc.) other than not offering tracts in these areas in Sale 193.

For purposes of environmental impact analysis, we assume that a 1-Bbbl oil field would be developed as a result of the sale. Alternative I (Proposed Action) includes the entire program area and is assigned an opportunity index of 1.0 (100% chance to discover the hypothetical oil field) (Table IV.A-3). Alternative II (No sale) has an opportunity for commercial success of zero because none of the area is available for leasing and exploration. Alternatives III and IV show the effects of deferral corridors along the coast to protect biological resources and subsistence uses. Alternative III includes the widest coastal deferral and reduces the opportunity by 36%.

IV.A.2.b. Exploration Activities.

IV.A.2.b(1) Marine Streamer 3D and 2D Seismic Surveys. The oil and gas industry conducts marine seismic surveys to locate geological structures potentially capable of containing petroleum accumulations. Airguns are the typical acoustic (sound) source for 2-dimensional and 3-dimensional (2D and 3D) seismic surveys. An outgoing sound signal is created by releasing a high-pressure air pulse from the airguns into the water to produce an air-filled cavity (a bubble) that expands and contracts. The size of individual airguns can range from tens to several hundred cubic inches (in³). A group of airguns is usually deployed in an array to produce a more downward-focused sound signal. Airgun array volumes for both 2D and 3D seismic surveys are expected to range from 1,800-4,000 in³, but may range up to 6,000 in³. The airguns are fired at short, regular intervals, so the arrays emit pulsed rather than continuous sound. While most of the energy is focused downward and the short duration of each pulse limits the total energy into the water column, the sound can propagate horizontally for several kilometers (Greene and Richardson, 1988; Hall et al., 1994).

Marine-streamer 3D seismic surveys vary markedly from typical 2D seismic surveys, because the survey lines are closer spaced and are more concentrated in a particular area. The specifications of a 3D survey depend on client needs, the subsurface geology, water depth, and geological target. A 3D source array typically consists of two to three subarrays of six to nine airguns each. The size of the source-array size can vary during the seismic survey to optimize the resolution of the geophysical data collected at any particular site. The energy output of the array is determined more by the number of guns than by the total array volume (Fontana, 2003, pers. commun.). Vessels usually tow up to three source arrays, depending on the survey-design specifications. Most operations use a single source vessel; however, in a few instances, more than one source vessel is used. The vessels conducting these surveys generally are 70-90 m long. The sound-source level (zero-to-peak) associated with typical 3D seismic surveys ranges between 233 and 240 decibels re 1 microPascal at 1 meter (dB re 1 μ Pa at 1 m). Marine 3D surveys are acquired at typical vessel speeds of 4.5 knots (kn) (8.3 km/hour). A source array is activated approximately every 10-15

seconds, depending on vessel speed. The timing between outgoing sound signals can vary for different surveys to achieve the desired “shot point” spacing to meet the geological objectives of the survey; typical spacing is either 25 or 37.5 m.

The receiving arrays could include multiple (4-16) streamer-receiver cables towed behind the source array. Streamer cables contain numerous hydrophone elements at fixed distances within each cable. Each streamer can be 3-8 km long with an overall array width of up to 1,500 m between outermost streamer cables. Biodegradable liquid paraffin is used to fill the streamer and provide buoyancy. Solid/gel streamer cables also are used.

The wide extent of this towed equipment limits both the turning speed and the area a vessel covers with a single pass over a geologic target. It is, therefore, common practice to acquire data using an offset racetrack pattern, whereby the each acquisition line is several kilometers away from and traversed in the opposite direction of the track line just completed. Acquiring a single track line may take several hours, depending on the size of the survey area. The vessel then takes 2-3 hours to turn around at the end of the track line and starts acquiring data along the next track line. Adjacent transit lines for a modern 3D survey generally are spaced several hundred meters apart and are parallel to each other across the survey area.

Seismic surveys are conducted day and night when ocean conditions are favorable, and one survey effort may continue for weeks or months, depending on the size of the survey. Data-acquisition is affected by the arrays towed by the survey vessel and weather conditions. Typically, data are only collected between 25% and 30% of the time (or 6-8 hours a day) because of equipment or weather problems. In addition to downtime due to weather, sea conditions, turning between lines, equipment maintenance, surveys could be suspended for biological reasons (proximity to protected species). Individual surveys could last 20-30 days (with downtime) to cover a 200 square mile (mi²) area.

Marine-streamer 2D surveys use similar geophysical-survey techniques as 3D surveys, but both the mode of operation and general vessel type used are different. The 2D surveys provide a less-detailed subsurface image because the survey lines are spaced farther apart, but they cover wider areas to image geologic structure on more of a regional basis. Large prospects are easily identified on 2D seismic data, but detailed images of the prospective areas within a large prospect can only be seen using 3D data.

The 2D seismic-survey vessels generally are smaller than modern 3D-survey vessels, although larger 3D-survey vessels are able to conduct 2D surveys. The 2D source array typically consists of three or more arrays of six to eight airguns each. The sound-source level (zero-to-peak) associated with 2D marine seismic surveys are the same as 3D marine seismic surveys (233-240 dB re 1 μ Pa at 1 m). Typically, a single hydrophone streamer cable approximately 8-12 km long is towed behind the survey vessel. The 2D surveys acquire data along single track lines that are spread more widely apart (usually several miles) than are track lines for 3D surveys (usually several hundred meters).

Marine seismic vessels are designed to operate for weeks without refueling or resupply. A guard or chase boat probably would be used for safety considerations, general support, maintenance, and resupply of the main vessel, but it would not be directly involved with the collection of seismic data. Helicopters also may be used, when available, for vessel support and crew changes.

Marine-streamer surveys require a largely ice-free environment to allow effective operation and maneuvering of the airgun arrays and long streamers. In the Arctic, the timing and areas of the surveys will be dictated by ice conditions. The data-acquisition season in the Chukchi Sea could start sometime in June and end sometime in early November. Even during the short summer season, there are periodic incursions of sea ice, so there is no guarantee that any given location will be ice free throughout the survey.

Marine seismic-exploration work is expected to begin before the sale to identify prospective tracts for bidding. This work is likely to include 3D seismic surveys but will not include exploration drilling. Approximately 100,000 line-miles of 2D seismic surveys already have been collected in the Chukchi Sea program area, so we assume that most of the additional geophysical surveys will be 3D surveys focusing on specific leasing targets. The 3D surveys are likely to continue during the early phase of exploration when wells are drilled; however, the number of surveys should decrease over time as data is collected over the prime prospects and these prospects are tested by drilling (see Table IV.A-2a). We assume that up to six

surveys could be conducted during each summer open-water season (June to November). Seismic surveys in the Chukchi OCS may be coordinated with surveys in the Beaufort OCS to use the same vessels.

IV.A.2.b(2) High-Resolution Site-Clearance Surveys. A high-resolution seismic survey usually is conducted by the oil and gas industry to provide the required permit information to MMS about the site of proposed exploration and development activities. High-resolution surveys locate shallow hazards; obtain engineering data for placement of structures (e.g., proposed platform locations and pipeline routes); and detect geohazards, archaeological resources, and certain types of benthic communities.

A typical operation consists of a vessel towing an acoustic source (airgun) about 25 m behind the ship and a 600-m streamer cable with a tail buoy. The source array usually is a single array composed of one or more airguns. A 2D high-resolution site-clearance survey usually has a single airgun, while a 3D high-resolution site survey usually tows an array of airguns. The ships travel at 3-3.5 kn (5.6-6.5 km/hour), and the source is activated every 7-8 seconds (or about every 12.5 m). All vessel operations are designed to be ultra-quiet, as the higher frequencies used in high-resolution work are easily masked by the vessel noise.

Typical surveys cover one OCS block at a time. The MMS regulations require information be gathered on a 300- by 900m grid, which amounts to about 129 line-kilometers of data per lease block. If there is a high probability of archeological resources, the north-south lines are 50 m apart and the 900 m remains the same. Including line turns, the time to survey a lease block is approximately 36 hours. Airgun volumes for high-resolution surveys typically are 90-150 in³, and the output of a 90-in³ airgun ranges from 229-233 dB high-resolution re 1μPa at 1m. Airgun pressures typically are 2,000 psi (pounds per square inch), although they can be used at 3,000 psi for higher signal strength to collect data from deep in the subsurface.

IV.A.2.b(3) Drilling Operations. Based on mapping of the subsurface structures using 2D and 3D seismic data, several well locations will be proposed. Prior to drilling deep test wells, high-resolution site clearance seismic surveys and geotechnical studies will examine the proposed exploration drilling locations for geologic hazards, archeological features, and biological populations. Site clearance and studies required for exploration will be conducted during the open water season before the drill rig is mobilized to the site.

Considering water depth and the remoteness of this area, drilling operations are likely to employ drillships with ice-breaker support vessels. Water depths >100 feet (ft) and possible pack-ice incursions during the open water season will preclude the use of bottom-founded platforms as exploration drilling rigs. Using drillships allows the operator to temporarily move off the drill site, if sea or ice conditions require it, and the suspended well is controlled by so-called blowout-prevention equipment installed on wellheads on the seabed. Drilling operations are expected to range between 30 and 90 days at different well sites, depending on the depth to the target formation, difficulties during drilling, and logging/testing operations. Considering the relatively short open-water season in the Chukchi (June-November), we estimate that up to four wells could be started by one rig each drilling season. However, it is more likely that only one to two wells could be drilled, tested, and abandoned during a single season, leaving work on the other wells to the next summer season. A total of 5 exploration wells have been drilled on the Chukchi shelf, and we estimate that 7-14 additional wells will be needed to discover and delineate the first commercial field.

IV.A.2.c. Development Activities.

When a large oil discovery is tested and defined by additional delineation wells, several project designs will be considered as alternatives for development. Because we have no knowledge of the site-specific conditions, we can only offer a general description of a possible future project and a hypothetical timeline for development.

Water depth and sea conditions are the two main factors in selecting a platform type. Because the continental shelf is relatively deep in the Chukchi (mostly deeper than 100 ft) and affected by ice movements most of the year, a large bottom-founded platform is likely to be used as a central facility. The platform would hold one to two drilling rigs, production and service (injection) wells, processing equipment, fuel- and production-storage capacity, and quarters for personnel. Although bottom-founded platforms have been used in high-latitude settings worldwide, no platform has operated in environmental conditions equivalent to the Chukchi shelf. Conceptual designs have been proposed that typically are

circular in cross-section with wide bases and constructed out of concrete. The platform could be constructed in several component sections which would be transported to the site and then mated together. The seafloor is expected to be relatively firm, so a prepared berm may not be required. The platform base is pinned to the seafloor and stabilized by its wide base, anchoring system, and ballast in cavities in the concrete structure to resist ice forces.

Because of limited topside space on the platform and the assumed widespread area of the oil pool, approximately half of all development wells could be subsea wells. The subsea wells would be completed in templates (4 wells per template) and production would be gathered to the central platform by flowlines. Subsea well templates would be located within about 15 miles (mi) from the central platform. Pending the information collected by site-specific surveys, the subsea equipment and pipelines could be installed below the seafloor surface for protection against possible deep-keeled ice masses. Drilling on the platform would occur year-round, while subsea wells would be drilled by drillships during the summer open-water season.

The production slurry (oil, gas, water) will be gathered on the central platform where gas and produced water will be separated and the produced water reinjected into the subsurface. Associated and solution gas recovered with oil production will be used as fuel for the facility or reinjected into the main reservoir to increase oil recovery. Shallow disposal wells will handle waste water and treated well cuttings for on-platform wells. Drilling cuttings and mud wastes from subsea wells could also be barged to an onshore treatment and disposal facility located at the shore base.

Installation of the flowlines from subsea templates to the hub platform and installation of the main oil pipeline from the platform to landfall will occur during summer open-water seasons. These pipeline operations would occur during the same timeframe as platform construction and installation. We assume that the offshore sales-oil pipeline will be larger than 18 inches (in) in diameter to handle production rates ranging from 200,000-250,000 barrels per day (bpd). The offshore pipeline runs 30-150 mi between the offshore platform and landfall and will be trenched in the seafloor as a protective measure against damage by floating ice masses. At the coast, a new facility will be constructed to support the offshore operations and will also serve as the first pump station. A likely location for the shore base would be between Icy Cape and Point Belcher.

The overland pipeline to the Trans-Alaska Pipeline System (TAPS) or a nearer gathering point (for example in the National Petroleum Reserve Alaska [NPR-A]) will require coordination of different land managers and oil-field owners along the route through NPR-A. In contrast to offshore pipelines, the new onshore pipeline will be installed during winter months. Various pipeline and communication lines will be installed on vertical supports above the tundra in a corridor stretching eastward up to 300 mi to connect to the North Slope gathering system. Pump stations may be required along the onshore corridor and are likely to be collocated with oil fields along the corridor.

An approximate timeframe for these activities is given in Table IV.A-2a. The time from leasing to production startup is expected to be 10-15 years. We assume a time lag of 3 years from the lease sale (2007) to the discovery well (2010). Delineation drilling would take 3 years, followed by permitting activities for the offshore project and a Development EIS. When the project is approved the design, fabrication and installation of the central platform could take another 4-5 years. Offshore and onshore pipeline permitting and construction would occur simultaneously with the offshore work. Drilling of subsea wells could start before platform installation to allow a quicker ramp up of production. Drilling on the platform and subsea wells would take 6 years. A new shore base would be constructed (2015) to support offshore work and then serve as the pipeline landfall.

IV.A.2.d. Production Activities.

The total lifecycle (exploration through abandonment) of the offshore project could last 30-40 years with oil production for at least 25 years (see Table IV.A-2b). When the oil resources are depleted, the platform and wells could be used for gas production, if producible quantities of gas are discovered and if a future North Slope gas pipeline is built and has available capacity to transport produced gas from the Chukchi Sea. Considering that a North Slope gas pipeline is unlikely to be operational until, at the earliest, 10-15 years from now and that there are large proven gas reserves closer to this future pipeline, full-scale gas production from the Chukchi OCS would not be expected before 2025 at the earliest, if it were to occur at

all. Some of the uncertainties that MMS considered in determining that a North Slope gas pipeline is speculative at this time, are presented in Section IV.A.2. Speculative future gas production and transportation is beyond the scope of the present analysis.

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

IV.A.2.e. Transportation Activities.

Operations at remote locations in the Chukchi Sale 193 area would require transportation of materials, supplies, and personnel by different means, depending on seasonal constraints and phase of the operations. The general assumptions discussed in this section can be integrated with the scenario schedule shown in Table IV.A-2a to determine the full extent of transportation activities associated with the single large offshore development project.

During exploration seismic surveys, the vessels are largely self-contained, so there would be a minimum amount of helicopter flights (assume 1 per day) to transport personnel, seismic data, and light supplies. As previously discussed, seismic operations would be in the summer open-water season (see also Table IV.A-2a for the annual number of seismic surveys). We assume that the smaller support vessel would make occasional trips (once every 2 weeks) to refuel and resupply (probably at Barrow).

During exploration drilling, operations would be supported by both helicopters and supply vessels. Helicopters probably would fly from Barrow at a frequency of one to three flights per day. Support-vessel traffic would be one to three trips per week, also out of Barrow. For exploration-drilling operations that occur after a new shore base is established near Point Belcher, both helicopter and vessel traffic would be out of either Barrow or the new shore base.

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

Offshore construction (platform and pipeline installation) and development drilling operations would be supported by both helicopters and supply vessels from the new shore base. Helicopters probably would fly from either Barrow or the new shore base at a frequency of one to three flights per day during development operations. Support-vessel traffic would be one to three trips per week from either Barrow or the new shore base. During normal production operations, the frequency of helicopter flights offshore would remain the same (1-3 per day), but marine traffic would drop to about one trip every 1-2 weeks to the production platform. Marine traffic would occur during the open-water season and possibly during periods of broken ice with ice-reinforced vessels. Assuming that barges will be used to transport drill cuttings and spent mud from subsea wells to an onshore disposal facility, we estimate one barge trip per subsea template (4 wells). This means that there could be two barge trips (during summer) to the new onshore facility over a period of 6 years (see Table IV.A-2b).

IV.A.2.f. Abandonment Activities.

After the oil reservoir is depleted and income from production does not cover operating expenses, operations will begin to shut-down the facility. In a typical situation, wells will be permanently plugged

(with cement) and wellhead equipment removed. Processing modules will be moved off the platform. Pipelines will be decommissioned, which involves cleaning the pipeline, plugging both ends, and leaving it in place buried in the seabed. The overland oil pipeline is likely to be used by other oil fields in the NPR-A and would remain in operation. Lastly, the platform will be disassembled and removed from the area and the seafloor site will be restored to some practicable, predevelopment condition. Post abandonment surveys would be required to confirm that no debris remains following abandonment or that materials (pipeline) that remain were abandoned property.

Other options are possible but more speculative. The platform might be converted to a gas production facility to recover the gas reinjected during oil production. This option will depend on construction of a future North Slope gas pipeline with capacity for new gas supplies from the Chukchi. Conversion of the offshore platform to a gas production facility could delay abandonment activities for several decades. Another option is that the platform and pipeline systems could serve as a hub for smaller satellite fields in the surrounding area. As a third option, the platform and partially dismantled topside facilities could be used for civilian or military purposes. For each option, abandonment activities would be delayed for many decades. Considering the cost of installing this offshore infrastructure (several billion dollars), it is unlikely that total abandonment of the facility would be considered as a cost-effective alternative.

IV.A.2.g. Estimates of Drilling Wastes and their Disposal.

Geologic studies indicate that exploration usually will test prospects from 3,000-15,000 ft in the subsurface. Based on the characteristics of the geologic plays, we assume that exploration wells will average 8,000 ft. Production and service wells are assumed to average 10,000 ft (drilled depth), because they will include deviated wells. We assume that from 25-33% of the total wells will be service wells that are used for waste disposal and reservoir pressure maintenance.

Estimates for drilling wastes are given in Table IV.A-1. For the assumed drilling depths, a typical exploration well will use 475 tons (ton = 2,000 pounds) of dry mud and produce 600 tons of dry rock cuttings. Considering the cost of synthetic drilling fluids now commonly used, we assume that 80% of the drilling mud will be reconditioned and reused. Only 20% (or 95 tons) of "spent mud" per well will be discharged at the exploration site. All of the rock cuttings will be discharged at the exploration site. A typical 10,000-ft production well will use approximately 625 tons of dry mud and produce approximately 825 tons of rock cuttings. We assume that 80% of the drilling mud will be recycled in the development drilling program, so 125 dry tons per well will be waste product. All waste products (drilling mud, rock cuttings, and produced water) for on-platform wells will be treated and then disposed of in shallow wells on the production platform. For the outlying subsea wells, drilling waste products could be barged to the coastal facility for treatment and disposal.

There is a variety of drilling fluid that could be used in well operations, each with a different composition. The type of drilling fluid used depends on its availability, the geologic conditions, and experiences of the drilling contractor. Often, several different types of drilling fluids are used in single well and most of the drilling fluids are recycled (80%). We assume that the discharged drilling fluid (20% of the total) will be a common water-base mud of the generic composition shown below. All of the expensive synthetic drilling muds are assumed to be reconditioned and not discharged. In any case, all fluid discharges are regulated by several Federal and State agencies so as not to have adverse environmental consequences.

Composition of Typical Drilling Mud (discharged at well site).

Bentonite	6.5%
Lignosulfonate	2.0%
Lignite	1.4%
Caustic	0.7%
Lime	0.3%
Barite	75.0%
Drilled solids	13.0%
Soda ash/Sodium Bicarbonate	0.4%
Cellulose Polymer	0.7%
Seawater/Freshwater	as needed
(EPA Type 2, Lignosulfonate Mud)	

IV.A.3. Disturbances.

Activities such as oil and gas exploration, development, and production could disturb the ecosystems in the area of operations. Unlike oil spills, which are accidental, some disturbances are expected to occur if normal exploration and development activities take place. In general, disturbance effects would result from industrial activities, noise, and habitat alteration.

IV.A.3.a. Industrial Activities.

Disturbances to the environment would occur from both exploration and, if an economic field is discovered, development and production activities. Exploration includes seismic activities and support activities. If exploration results in a commercial discovery, then during the construction and operation phases, additional support activities would occur.

Under our hypothetical scenario, activities such as seismic surveys would take place in the summer, open-water months between June and November. Construction of offshore production and transportation facilities could be carried out during the summer months and completed in 1-2 years. Construction of onshore support and transportation facilities could be carried out during the summer and winter months simultaneously with offshore work. Once construction is complete, production facility operations would occur year-round, over a 25-year period. The analyses in Section IV.C.1 describe and evaluate the effects of noise (seismic and drilling activities), habitat alterations (construction of platforms and pipelines), and discharges to both the air and water.

IV.A.3.b. Noise.

Human sources of sound in the Chukchi Sea area include sound from vessels (motor boats used for subsistence and local transportation, commercial shipping, research vessels, etc.); navigation and scientific research equipment; airplanes and helicopters; human settlements; military activities; and marine development. Noise is a subset of sound, referring to sound unwanted by the entity that hears it. An opposite of noise is a signal: a sound containing useful or desired information. Thus, any individual sound may be a signal to some and a noise to others. 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 and marine birds, as well as Native Alaskan subsistence activities affected by these mammals and birds.

Underwater sound essentially is the transmission of energy via compression and rarefaction of particles in the conducting medium (i.e., in this case, seawater). The pressure pulse from a sound source propagates outwards in an expanding spherical shell at approximately 1,500 meters per second (m/s) (in seawater). As the shell expands, the energy contained within it is dispersed across an ever-increasing surface area, and the energy per unit area decreases in proportion to the square of the distance traveled from the source.

Properties of sound that influence how far that sound is transmitted, what species hear it, and what physical and behavioral effects it can have include: its intensity, frequency, amplitude, wavelength, and duration; distance between the sound source and the animal; whether the sound source is moving or stationary; the level and type of background noise; and the auditory and behavioral sensitivity of the species (Richardson et al., 1995a). The frequency of the sound is usually measured in Hertz, pressure level in microPascals (Gausland, 1998), and intensity levels in decibels (Richardson et al., 1995a; McCauley et al., 2000). McCauley et al. (2000) and others (see references in McCauley et al., 2000) express this in terms of its equivalent energy dB re $1 \mu\text{Pa}^2$. The perceived loudness of any given sound is influenced by many factors, including both the frequency and pressure of the sound (Gausland, 1998), the hearing ability of the listener, the level of background noise, and the physical environment through which the sound traveled before reaching the animal.

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

1. Sound travels faster and with less attenuation in water than it does in air.
2. The fate of sound in water can vary greatly, depending on characteristics of the sound itself, characteristics of the location where it is released, characteristics of the environment through which it travels (Richardson et al., 1995a; McCauley et al., 2000), and the characteristics (for example, depth, orientation) of the receiver (Richardson et al., 1995a; Gausland, 1998).
3. Sound propagation can vary seasonally in the same environment.
4. Extrapolation about the likely characteristics of a given type of sound source in a given location within the Chukchi and Beaufort seas based on published studies conducted elsewhere is somewhat speculative, because characteristics of the marine environment such as bathymetry, sound-source depth, and seabed properties greatly impact the propagation of sound horizontally from the source (McCauley et al., 2000; see also Chapter 4 in Richardson et al., 1995a and references provided therein). Richardson et al. (1995a:425) summarized that: "...a site-specific model of sound propagation is needed to predict received sound levels in relation to distance from a noise source." Especially within the Chukchi Sea Planning Area, differences in site characteristics in different parts of the planning area make predictions about sound propagation relatively difficult.
5. Because the air-water interface acts as a good reflector, sound generated underwater generally will not pass to the air (Gausland, 1998).

Measurement of underwater sound levels historically has been complicated by a system of inconsistent and confusing units. Sound pressures in underwater sound studies are reported in terms of peak-peak, 0-peak, peak-equivalent rms, and rms (root-mean-square) (Madsen, 2005). Root-mean-square is linked to the derivation of power measurements from oscillating signals. The magnitude of sound pressure levels in water normally is described by sound pressure on a decibel scale relative to a reference rms pressure of 1 μPa (dB re 1 μPa) (Madsen, 2005).

Results from underwater-noise studies can be difficult to evaluate and compare, as decibel levels may vary by 10 dB or more between the different units of measure. Sound pressure of continuous sound sources normally is parameterized by an rms measure, while transient sound normally is given in peak pressure measures.

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

IV.A.3.b(1) Vessel Activities and Traffic. Shipping noise, often at source levels of 150-190 dB, since 1950 has contributed a worldwide 10- to 20-dB increase in the background noise in the sea (Acoustic Ecology Institute, 2005). The types of vessels that produce noise in the Beaufort and Chukchi seas include barges, skiffs with outboard motors, icebreakers, scientific research vessels, and vessels associated with geological and geophysical exploration and oil and gas development and production. In the Beaufort and Chukchi seas, vessel traffic and associated noise presently is limited primarily to late spring, summer, and early autumn.

In shallow water, vessels more than 10 km away from a receiver generally contribute only to background noise (Richardson et al., 1995a). In deep water, traffic noise up to 4,000 km away may contribute to background-noise levels (Richardson et al., 1995a). Shipping traffic is most significant at frequencies from 20-300 Hz (Richardson et al., 1995a). Barging associated with activities such as onshore and limited offshore oil and gas activities, fuel and supply shipments, and other activities contributes to overall ambient noise levels. The use of aluminum skiffs with outboard motors during spring subsistence whaling in the Chukchi Sea also contributes noise. Fishing boats in coastal regions also contribute sound to the overall ambient noise. Sound produced by these smaller boats typically is at a higher frequency, around 300 Hz (Richardson et al., 1995a).

Icebreaking vessels used in the Arctic for activities including research and oil and gas activities produce stronger, but also more variable, sounds than those associated with other vessels of similar power and size (Richardson et al., 1995a). Even with rapid attenuation of sound in heavy ice conditions, the elevation in noise levels attributed to icebreaking can be substantial out to at least 5 km (Richardson et al., 1991). In some instances, icebreaking sounds are detectable from more than 50 km away. In general, spectra of icebreaker noise are wide and highly variable over time (Richardson et al., 1995a).

IV.A.3.b(2) Marine-Streamer 3D, 2D, and High Resolution Seismic Surveys. The sound is created by the venting of high-pressure air from the airguns into the water column and the subsequent production of an air-filled cavity (a bubble) that expands and contracts, to peak levels. Airgun sizes are quoted as chamber volumes in cubic inches, and individual guns may vary in size from a few tens to a few hundreds of cubic inches. While the seismic airgun pulses are directed towards the ocean bottom, sound propagates horizontally for several kilometers (Greene and Richardson, 1988; Hall et al., 1994). In waters 25-50 m deep, sound produced by airguns can be detected 50-75 km away, and these detection ranges can exceed 100 km in deeper water (Richardson et al., 1995a). Typically an airgun array is towed behind a vessel at 4-8 m depth and is fired every 10-15 seconds. The ship also may be towing long cables with hydrophones (streamers), which detect the reflected energy from the subsurface.

Airgun-array sizes are quoted as the sum of their individual airgun volumes and again can vary greatly. The array output is determined more by the number of guns than by the total array volume (Fontana, 2003, pers. commun.). For single airguns the zero-peak acoustic output is proportional to the cube root of the volume. As an example, compare two airgun configurations with the same total volume. The first array consists of one airgun with a total volume of 100 in³ resulting a cube root of 4.64. The second array has the same total volume, but consists of five 20-in³ guns. The second array has an acoustic output nearly three times higher (5 times the cube root of 20 = 13.57) than the single gun, while the gun volumes are equal. The output of a typical two-dimensional (2D/3D) array has a theoretical point-source output of ~255 dB \pm 3 dB (Barger and Hamblen, 1980; Johnston and Cain, 1981); however, this is not realized in the water column, and maximum real pressure is more on the order of 232 dB \pm 3dB and typically only occurs within 1-2m of the airguns.

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

Seismic sounds vary, but a typical 2D/3D seismic survey with multiple guns would emit energy at about 10-120 Hz, and pulses can contain energy up to 500-1,000 Hz (Richardson et al. 1995a). Goold and Fish (1998) recorded a pulse range of 200 Hz-22 kiloHerz (kHz) from a 2D survey using a 2,120-in³ array. Airgun volumes associated with high-resolution surveys typically are 90-150 in³, and the output of a 90-in³ airgun ranges from 229-233 dB re 1 μ Pa at 1m. Noise incidental to the seismic activities is introduced by the vehicles associated with the activity.

IV.A.3.b(3) Oil and Gas Development and Production Activities. There currently is one operating oil-production facility on an artificial island and several others in planning and construction stages in the Beaufort Sea. There are two other developments on causeways. Typically, noise propagates poorly from artificial gravel islands, as it must pass through gravel into the water (Richardson et al., 1995a). Much of the production noise from oil and gas operations on gravel islands is substantially attenuated within 4 km and often not detectable at 9.3 km.

Recently Richardson and Williams (2004) summarized results from acoustic monitoring of the offshore Northstar production facility from 1999-2003. Northstar is located on an artificial gravel island in the

central Alaskan Beaufort Sea. In the open-water season, in-air broadband measurements reached background levels at 1-4 km and were not affected by vessel presence. However, Blackwell and Greene (2004) pointed out that "...an 81 Hz tone, believed to originate at Northstar, was still detectable 37 km from the island." Based on sounds measurements of noise from Northstar obtained during March 2001 and February-March 2002 (during the ice-covered season), Blackwell, Greene, and Richardson (2004) found that background levels were reached underwater at 9.4 km when drilling was occurring and at 3-4 km when it was not. Irrespective of drilling, in-air background levels were reached at 5-10 km from Northstar.

During the open-water season, vessels such as tugs, self-propelled barges, and crew boats were the main contributors to Northstar-associated underwater-sound levels, with broadband sounds from such vessels often detectable approximately 30 km offshore. In 2002, sound levels were up to 128 dB re 1 μ Pa at 3.7 km, when crew boats or other operating vessels were present (Richardson and Williams, 2003). In the absence of vessel noise, averaged underwater broadband sounds generally reached background levels 2-4 km from Northstar. Underwater-sound levels from a hovercraft, which BPXA began using in 2003, were quieter than similarly sized conventional vessels.

Typically, noise propagates poorly from artificial islands, as it must pass through gravel into the water (Richardson et al., 1995a). Richardson et al. (1995a) reported that during unusually quiet periods, drilling noise from ice-bound islands would be audible at a range of about 10 km, when the usual audible range would be ~2 km. Richardson et al. (1995a) also reported that broadband noise decayed to ambient levels within ~1.5 km, and low-frequency tones were measurable to ~9.5 km under low ambient-noise conditions, but were essentially undetectable beyond ~1.5 km with high ambient noise.

IV.A.3.b(4) Miscellaneous Sources. Acoustical systems are associated with some research, military, commercial, or other vessel use of the Beaufort or Chukchi seas. Such systems include multibeam sonar, sub-bottom profilers, and acoustic Doppler current profilers. Active sonar is used for the detection of objects underwater. These range from depth-finding sonar, found on most ships and boats, to powerful and sophisticated units used by the military. Sonar emits transient, and often intense, sounds that vary widely in intensity and frequency. Acoustic pingers used for locating and positioning oceanographic and geophysical equipment also generate noise at high frequencies. LGL, Ltd. (2005) describes many examples of acoustic navigational equipment.

IV.A.3.c. 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 such activities as construction, new types of infrastructure, alteration of stream flow, influx of different cultural groups, and an increase in available jobs. All of the resources discussed in this EIS could be affected through habitat alteration. An alteration to the habitat of the marine mammals, birds, and other marine life significantly could alter the cultural resources and quality of life of the Native Alaskan people.

IV.A.3.d. Discharges to the Marine Environment.

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

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

Pollution to the marine environment resulting from any OCS oil and/or gas activities come from two primary sources: point sources and nonpoint sources.

IV.A.3.d(1) Point-Source Pollution. The term *point source* is defined very broadly in the Clean Water Act (CWA) and has been through 25 years of litigation. Point source has come to mean any discernible

direct or specific discharge; as from a pipe, action, or operation. It also includes vessels or other floating craft from which pollutants are or may be discharged. The CWA prohibits anybody from discharging “pollutants” through a “point source” into a “water of the United States,” unless they have a National Pollution Discharge Elimination System (NPDES) permit. The permit contains limits on what you can discharge, monitoring and reporting requirements, and other provisions to ensure that the discharge does not hurt water quality or people’s health. The USEPA issued the final Arctic General permit in June, 2006. The general permit covers discharges from exploration in the Chukchi Sea Planning Area.

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

IV.A.3.d(2) Nonpoint-Source Pollution. Nonpoint-source pollution resulting from oil- and gas-field activities and operations, unlike pollution discharges from industrial operations and plants, comes from many sources. Nonpoint-source pollution is caused by marine waters, rainfall, or snowmelt, coming into contact with site buildings and facility components (deck/pad, machinery, material, pipelines, etc). As the runoff moves across a facility, it picks up and carries away natural and human-made pollutants and deposits them into marine and coastal waters. These pollutants include:

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

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

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

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

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

applicable State and Federal agencies, as well as states within their coastal nonpoint programs which, under CZARA, are to provide for the implementation of management measures.

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

For the purpose of this assessment, compliant oil and gas operations in the foreseeable future will not have any significant impact to water quality resulting from oil- and gas-field operations sources.

IV.A.3.e. Emissions to the Air.

Industrial air emissions from support-vessel traffic; construction machinery; and production equipment, including compressors, generators, boilers, and various types of internal combustion engines, would affect on air quality. Other effects on air quality would come from spilled oil, either due to evaporation or in situ burning of hydrocarbons, in the event of an oil spill. A more complete discussion on air quality is found in Section IV.C.1.b.

IV.A.4. Oil Spills.

A major concern of the public is the potential effects of oil spills. The oil-spill analysis considers two spill-size categories: (1) large spills, those greater than or equal to (\geq) 1,000 bbl, and (2) small spills, those <1,000 bbl. The oil-spill-trajectory model addresses the movement of large spills \geq 1,000 bbl. The oil-spill-trajectory model results are appropriate only for “large” spills \geq 1,000 bbl. 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 \geq 1,000 bbl. This introduction summarizes the assumptions we use to analyze large oil spills for each alternative. The section locations for the analysis of small and 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.1. 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 a mean spill number ranging from 0.33-0.51 for Sale 193 Alternative I or its alternatives. 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 mean spill number of 0.51 (half a spill) over the life of the field may be ‘high.’

For purposes of analysis, we assume one large spill occurs at any location open to leasing in the full Proposed Action area. This “what-if” analysis of a large oil spill addresses whether such spills could cause serious environmental impact.

The analysis of a large spill represents the range of effects that might occur from a range of offshore or onshore spill sizes from Alternative I for Sale 193 or its alternatives. Table IV.A-4 shows the large spill

sizes we assume for purposes of analysis range from a platform spill of 1,500 bbl for crude or diesel oil to a pipeline spill of 4,600 bbl of crude oil. The large spill sizes are broken out as follows:

Crude oil or Diesel oil

- production facility (includes storage tanks), 1,500 bbl or

Crude oil

- offshore pipeline, 4,600 bbl

For further information on how we derive the information in Table IV.A-4, please read Appendix A.1.

In terms of timing, a large spill from the Sale 193 Alternative I or its 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 could reach the following environments:

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

The analysis of a large spill examines the weathering of the assumed spill. We assume the oil will be similar to Alpine composite crude oil. The assumed spill size is either 1,500 or 4,600 bbl. 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 June through October, and a winter spill melts out in June. For open water, we model the weathering of the 1,500- or 4,600-bbl 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. Appendix A, Tables A.1-9, A.1-10 and A.1-11 summarize the results we assume for the fate and behavior of Alpine composite 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 40-57 % evaporates, 2-53% disperses, and 0-55% 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 large spill size is one of the sizes we show in Table IV.A-4.
- All the oil reaches the environment; the production facility absorbs no oil.
- The large spill starts at the production facility or along the offshore pipeline.
- There is no cleanup or containment. Cleanup and containment are considered mitigating factors.
- The large spill could occur at any time of the year.
- The large spill weathering is as we show in Appendix A, Tables A.1-9 A.1-10 and A.1-11
- A large spill that moves into the landfast ice from the production facility or its pipeline does not move significantly until the ice breaks up (Appendix A).
- The large spill area varies over time as we show in Appendix A Tables A.1-9 A.1-10 and A.1-11 and is calculated from Ford (1985).
- The time and chance of contact from a large oil spill are calculated from an oil-spill-trajectory model (Appendix A, Tables A.2-1 through A.2-72).
- The chance of contact is analyzed from the location where it is highest when determining effects.

- The overall chance of one or more large oil spills occurring and contacting is calculated from an oil-spill-risk analysis model (Appendix A. Tables A.2-73 through A.2-90).

IV.A.4.a(1) The Chance of One or More Large Spills Occurring. The chance of one or more large spills occurring does not factor in the chance that a development project occurs. Given the many logistical, economic, and engineering factors, there is probably a <10% chance that a commercial field will be leased, discovered, and developed. However, because leasing and exploration could lead to a development project, MMS must evaluate what would happen if a development occurred, even though the chance of that happening is probably very small in a frontier area like the Chukchi Sea.

For Alternative I, the Proposed Action, our oil-spill-risk analysis of one or more large spills occurring assumes there is a 100% chance that a project will be developed and 1 Bbbl of oil will be produced. Clearly, this overstates the oil-spill occurrence associated with leasing and exploration in the Chukchi Sea where it is unlikely a development will occur from those activities. If a development occurs, this oil-spill analysis more accurately represents the chance of one or more large spills occurring. Alternatives III and IV are handled in the same way, assuming the resources will be developed.

The chance of one or more large spills occurring assumes there is a 100% chance that a project will be developed and 1 Bbbl of oil will be produced. The large spill rates used in this section are all based on spills per billion barrels produced. The chance of one or more large spills occurring is derived from two components: (1) the spill rate and (2) the resource volume estimates. The spill rate is multiplied by the resource volume to estimate the mean number of spills. Oil spills are treated statistically as a Poisson process, meaning that they occur independently of one another. If we constructed a histogram of the chance of exactly zero spills occurring during some period, the chance of exactly one spill, two spills, and so on, the histogram would have a shape known as a Poisson distribution. An important and interesting feature of this distribution is that it is entirely described by a single parameter, the mean number of spills. Given its value, you can calculate the entire histogram and estimate the chance of one or more large spills occurring.

For the Proposed Action, we estimate 0.30 pipeline spills and 0.21 platform (and well) spills for a total over the life of Sale 193 production of 0.51 spills. For the Proposed Action, using spill rates at the 95% confidence interval, total spills range from 0.32-0.77 spills over the production life of the action. For purposes of analysis, one large spill was assumed to occur and is analyzed in this EIS.

We estimate the chance of one or more large pipeline spills is 26%, and the chance of one or more large platform spills is 19% for Alternative I - the Proposed Action over the production life of the project. The total is derived from the sum of the platform, wells and pipeline mean number of spills. The chance of one or more large spills total is 40% for Alternative I - the Proposed Action over the production life of the project. For Alternative I - the Proposed Action, the percent chance of one or more large spills total ranges from 27-54% at the 95% confidence interval over the production life of the project.

We estimate the chance of one or more large pipeline spills is 17%, and the chance of one or more large platform spills is 12% for Alternative III - Corridor 1, over the production life of the project. The total is derived from the sum of the platform, wells and pipeline mean number of spills. The chance of one or more large spills total is 28% for Alternative III - Corridor 1 over the production life of the project. For Alternative III - Corridor 1, the percent chance of one or more large spills total ranges from 18-39% at the 95% confidence interval over the production life of the project.

We estimate the chance of one or more large pipeline spills is 22%, and the chance of one or more large platform spills is 16% for Alternative IV - Corridor 2 over the production life of the project. The total is derived from the sum of the platform, wells, and pipeline mean number of spills. The chance of one or more large spills total is 35% for Alternative IV - Corridor 2 over the production life of the project. For Alternative IV - Corridor 2, the percent chance of one or more large spills total ranges from 24-48% at the 95% confidence interval over the production life of the project.

IV.A.4.a(2) The Chance of One or More Large Spills 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. The chance of one or more large spills occurring and contacting

ERA's or land segments is 7% or less over 30 days or 14% or less over 360 days for Alternative I. The chance of one or more large spills occurring and contacting ERA's or land segments is 3% or less over 30 days or 8% or less over 360 days for Alternative III. The chance of one or more large spills occurring and contacting ERA's or land segments is 5% or less over 30 days or 11% or less over 360 days for Alternative IV.

A potential resource benefit of the deferrals would be derived from the increasing distance of exploration and production facilities from the shoreline. The increased distances slightly reduce the percent chance of one or more large spills occurring and contacting sensitive coastal resources over the lifetime of the project, and the increased time required for oil to travel this greater distance conceivably would allow for a more effective response from spill-response depots if a large oil spill were from a facility.

IV.A.4.b. Small Spills.

Small spills, although accidental, generally are routine and expected. We estimate small spills are likely to occur based on a mean spill number ranging from 115-179 for crude oil and 282-440 for refined oil for Alternatives I, III, and IV for Sale 193. 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 bbl for spills <500 bbl and 680 bbl for spills 500 bbl-<1,000 bbl (State of Alaska, Department of Environmental Conservation [ADEC], 2001). Table IV.A-5 shows the estimated number and volume of small crude oil spills for purposes of analysis.

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 (ADEC, 2001).

The typical refined products spilled are aviation fuel, diesel fuel, engine lube, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil (ADEC, 2001). Diesel spills are 58% of refined oil spills by frequency and 83% by volume. Engine-lube oil spills are 10% by frequency and 3% by volume. Hydraulic oil is 26% by frequency and 10% by volume. All other categories are less than 1% by frequency and volume. For purposes of analysis, this EIS assumes an average refined-spill size of 0.7 bbl. Table IV.A-6 shows the estimated number and volume of refined spills.

IV.A.4.c. Locations of Oil-Spill Analyses.

Analysis of the effects of large and small spill from Alternative I for Sale 193 and its alternatives is found in Section IV.C.1 through IV.C.3. Supporting documentation for the assumptions we use in the oil-spill analysis in this EIS is found in Appendix A. For more information on the analysis of oil spills, see Appendix A of this EIS and Johnson, Marshall, and Lear (2007) *Oil Spill Risk Analysis: Chukchi Sea Sale 193*.

IV.A.5. Spill Prevention and Response.

Each permittee operating offshore in the Chukchi Sea is required to meet applicable Federal and State pollution-prevention and oil-spill-response requirements for each activity site. An activity site would be the exploration site, drilling site, or production site, each with its ancillary facilities. The MMS regulations governing these operations are found in 30 CFR 250 and 254. Operators also are responsible for complying with provisions of the USEPA regulations 40 CFR 110, 112, and 300 that are applicable to oil and gas operations on the OCS. The ADEC oversees State of Alaska prevention and spill response planning requirements which are found in 18 AAC 75.

The MMS' primary focus is on pollution prevention by requiring operators to take measures to prevent unauthorized discharges of pollutants into offshore waters. These requirements are specified in 30 CFR 250. The MMS regulations address all facets of offshore operations from exploration activities through abandonment and destruction of the facilities. Operators are required to use the best available and safest technology and industry practices to ensure their facilities are designed, operated, and maintained in such a

manner as to ensure proper well control and to limit the potential for oil and hazardous material releases to the environment.

Operators are required by regulation to conduct periodic inspections and tests of facility systems such as blowout preventers, valves, and subsea pipelines to ensure they are operating within established limits. Specific training on well-control practices is required for employees assigned to well-control and production-safety duties along with weekly well-control drills. The MMS conducts routine inspections of offshore facilities and may initiate well-control drills to verify operator competency and compliance with the regulations. By congressional action, MMS has been 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.

In instances where there is a heightened concern about an aspect of offshore operations, MMS may require additional equipment or controls to mitigate these concerns. For example, in the Beaufort Sea detection of small, chronic leaks from subsea pipelines that are obscured from view by a solid sheet of ice much of the year was identified as a critical element in reducing the size and impact of a potential release to the environment. One approval requirement the U.S. Army Corps of Engineers imposed on BPXA's Northstar facility was that the operator develop a prototype leak-detection system capable of detecting releases below the current state-of-the-art leak-detection systems to be used on the oil-transmission lines. BPXA selected the German-made LEOS (Leck Erkennung Ortungs System) (Bryce, Jax, and Fang, 2002), which is strapped to the exterior of the pipeline and detects leaks by collecting vapors through a liquid impermeable acetate layer within a perforated tube. The collected vapors are screened every 24 hours for specific hydrocarbon compounds that, if detected, could indicate the pipeline has begun to leak. The LEOS system has been proven to detect leaks equal to <1% of the total daily pipeline flow. This type of technology will help prevent large undetected oil spills from small chronic leaks under the ice.

Oil-spill response is specifically addressed under 30 CFR 254, Oil-Spill Response Requirements for Facilities Located Seaward of the Coast Line. These regulations implement the requirements established by the Oil Pollution Act of 1990 for offshore oil and gas operations. Each operator is required to prepare an oil-spill-response plan (OSRP) for their facilities seaward of the coastline. In the OSRP, the operator must include an emergency-response-action plan, a worst-case-discharge (WCD) scenario, an inventory of response equipment to support a WCD response, contractual agreements with oil-spill-removal organizations (OSRO) who will provide response services, a dispersant-use plan, an in situ-burning plan, and a training- and response-drills plan. Prior to the start of drilling operations, the operator must have an MMS-approved oil-spill-response plan.

In developing the WCD scenario, operators are required to conduct an appropriate trajectory analysis for the area where the facility will be located. This analysis must identify onshore and offshore areas that a discharge potentially could impact and further identify resources of special economic or environmental concern that may be present. The operator must describe what strategies would be used to protect these areas and resources. The MMS may require operators to demonstrate proposed spill-response strategies before approval of an OSRP is granted. When determining equipment requirements for the WCD, the operator is required to derate the throughput capacity of skimmers by 20% to compensate for environmental factors such as sea state, temperature, available daylight, and emulsification of the oil to ensure sufficient recovery capabilities. The MMS, through its approval action, also may require operators to stage spill-response equipment near areas of concern to facilitate more rapid deployment to protect critical resources and limit exposure to the oil.

The MMS conducts routine inspections of the operator's facilities to ensure that the identified spill-response resources are readily available and in the quantities and condition described in the OSRP. Inspections of response equipment owned by OSRO's also are conducted to verify response readiness. Reviews of training records and spill-drill reports are made to verify that response personnel have completed the mandatory training and that all facets of the OSRP have been exercised as required in the regulations. The MMS also will conduct announced and unannounced spill drills to test the operator's ability to carry out the provisions of the OSRP. Based on the results of these drills, MMS may require the operators to amend their OSRP to improve response operations.

In addition to the MMS regulations, operators are responsible for ensuring their OSRP is consistent with the National Response Plan (NRP); the Area Response Plan, which in Alaska is the Unified Plan for Preparedness to Oil Discharges and Hazardous Substance Release (Unified Plan); and appropriate Subarea Contingency Plans depending on facility location, i.e., the North Slope or Northwest Arctic. The NRP, the Unified Plan, and the Subarea Contingency Plans are Federal/State response plans that describe the governmental response network nationally and within the State of Alaska. The Subarea Contingency Plans identify response resources and environmentally sensitive areas within each of the State's 10 geographic subareas. These plans are developed and managed by USEPA, U.S. Coast Guard (USCG), and ADEC with support from Federal, State, Local and Tribal government resource managers.

Should an oil spill occur on the OCS, the operator is required to immediately implement their OSRP and notify the National Response Center about the spill. They must also immediately notify MMS if the spill is 1 bbl or larger. It is up to the operator to mobilize sufficient equipment and personnel to control, contain, and clean up the spill to the greatest extent possible. In the event that the spill volume is large or there are critical resources in danger, cleanup operations may be directed by the Unified Command. The UC is composed of the Responsible Party (RP); the Federal On-Scene Coordinator (FOSC), who for offshore events is from the USCG; and the State On-Scene Coordinator (SOSC), who is a representative from ADEC. This group works jointly to establish spill-response priorities and direct overall response activities. If the RP is unable to adequately carry out response activities, the FOSC and SOSC have the option to take over the response to ensure appropriate response actions are taken.

Effectiveness of cleanup operations is highly dependent on volume, location, and time of year in Alaska. A small spill occurring during winter on land or on solid ice and snow can be readily cleaned up using conventional land-based equipment such as shovels, snowblowers, and bulldozers, resulting in a near 100% recovery rate. Spills to open-water and broken-ice conditions result in lower recovery rates of 10-20% of the spilled oil. Removal of a spill on water requires the deployment of containment boom to corral and concentrate the oil into a recoverable thickness, skimmers to remove the oil from the water surface, temporary storage vessels to hold the recovered oil and water and vessels to deploy the equipment and personnel. Recovery rates are lower on water because the oil can disperse rapidly throughout the area, and responders must first locate and contain the spill before it can be recovered.

In addition to mechanical means of oil-spill response, operators are required to have access to the equipment and chemicals required to conduct an in-situ burn (ISB) of oil on the water's surface or apply chemical dispersants to break up the oil slick and distribute it into the water column. An ISB has the potential to rapidly remove in excess of 90% of the oil in the burn area and is considered to be one of the better response options in broken-ice conditions where the ice acts as a containment boom naturally concentrating the oil. Chemical dispersants also are becoming a more accepted option, and recent research has determined that they can be an effective spill-response tool in cold water. Use of either of these response methods requires approval from the FOSC and/or the SOSC, depending on the location of the oil.

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.

IV.B.1. Effects of Alternative II.

Under this alternative, the leasing action evaluated in the Chukchi Sea EIS would not be approved. Should this occur, there would be no leases offered in the Chukchi Sea under the 2007-2012 5-Year Program, no exploration drilling would occur, and no oil and gas would be developed from this offshore area. If the estimated 1 Bbbl of oil is not produced, there would be no chance of oil spills occurring and no effects to the flora and fauna either on- or offshore the Chukchi Sea coast. There would be no noise, habitat disturbance and alteration, or water discharges and air emissions from the activities associated with

exploration and development/production operations. The economic benefits, including direct income to the Federal government (bonus bids, rental, royalties, and corporate taxes) and indirect income to the State and local governments (property taxes, personal income, among others), would also be delayed or lost, as would any associated employment opportunities and the use of any oil and gas that may have been produced.

To replace the potential 1 billion barrels of oil not developed from this Chukchi Sea sale, an equivalent volume of oil will be needed from other sources, including domestic and imported oil. For perspective, the current supply/demand balance in the United States is approximately 21 million barrels (MMbbl) per day (or 7.7 Bbbl per year). At peak production, the hypothetical oil field in the Chukchi would produce an estimated 225,000 bbl per day, or about 1% of total U.S. demand. The associated environmental impacts from gathering oil supplies from other sources still would occur, but not in this area of the country. Oil imports have attendant environmental effects (possible oil spills) as well as negative economic effects on the Nation's balance of trade.

If the No Lease Sale alternative is adopted, the projected environmental and economic effects of the Proposal would not occur. Similar effects could occur elsewhere, perhaps with a slightly different magnitude. Biological resources in the Arctic Ocean could still be exposed to other ongoing oil and gas activities in the adjacent onshore (North Slope of Alaska) area, as well as adjacent offshore areas in the Russia and Canada.

IV.B.2. Possible Substitutes for Delayed or Lost Oil and Gas Production.

The energy needed by the United States economy would likely be replaced by other sources. Because most of the oil would be refined into fuel for transportation uses, alternative fuel sources could include:

- domestic oil production from other areas (onshore and offshore)
- imported oil production (pipelines from Canada and tankers from overseas)
- methanol and other gasoline additives

Oil used for power generation could be replaced by:

- natural gas (or imported LNG)
- hydroelectric power
- nuclear power
- fuel switching (fuel oil to natural gas)
- renewable energy sources, such as wind or solar power

If the proposed Chukchi Sea sale is denied, or commercial development does not occur, substitute energy sources would probably be a mix of the above alternatives. Energy conservation measures would be applicable to both fuel and power demands in the future.

A paper from the recent 1997-2002 5-Year OCS Oil and Gas Program entitled *Energy Alternatives and the Environment* (USDO, MMS, 2001a), which is incorporated here by reference, discusses a long list of alternatives to oil and natural gas and evaluates their potential to replace a critical part of our country's energy sources. The costs and reliability of these alternative sources make them less viable (more costly to consumer and less available for widespread distribution) than oil and gas reserves. It seems very likely that during the life of this project, oil and gas demand will rise above current levels in the United States and the world as economies grow. The paper also concludes that imports and additional domestic production could easily replace most of the missing oil production from the Chukchi, and conservation and fuel switching will decrease the demand for new crude oil supplies. Every energy alternative, however, imposes its own negative environmental effects somewhere. The following list shows the approximate percent and quantity we expect would substitute for the lost oil (1 Bbbl). The quantity of conservation and fuel switching are in barrels of oil equivalent.

- Additional imports: 88% of the loss of production equivalent to 880 MMbbl.
- Conservation: 5% of the loss in production equivalent to 50 MMbbl.

- Additional domestic production: 4% of the loss in production equivalent to 40 MMbbl.
- Fuel switching: 3% of the loss in production equivalent to 30 MMbbl.

As shown above, the major source for replacement is imported oil. Most of this oil will be delivered to the U.S. by tankers. Assuming an average tanker size of 125,000 deadweight ton (DWT) (carries 1 MMbbl), importing this volume of oil would require 880 tanker trips through U.S. waters.

IV.B.3. Environmental Impacts from the Most Important Substitutes.

IV.B.3.a. Additional Oil Imports.

Energy Alternatives and the Environment (USDOJ, 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 Proposed Action, 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 (or adjacent U.S. waters) from accidental discharges of oil, whether from tanker or pipeline spills. These events could:

- 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 and fauna in localities directly impacted by spills.

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 marine trade routes. By not producing domestic oil and gas reserves and relying on imported oil we are exporting, from a global perspective, a sizeable portion of the environmental impacts to other those countries.

IV.B.3.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. Adding insulation to buildings, improving efficiency in engines, and consuming less energy will result in cost savings in the long run. The development of energy-saving technologies creates jobs. Various measures to improve the efficiency of energy use could be employed, but the relationship between total energy consumption and gross domestic product is inescapable.

IV.B.3.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 Proposed Action but they would occur in a different location. To the extent other offshore production offsets the potential loss of production from the Chukchi Sea, the effects will be similar to those of the Proposed Action but would occur in a different location. Offshore activities also may have adverse impacts to recreation and tourism very important to other coastal areas of the country.

IV.B.3.d. Fuel Switching.

Some consumers could switch to natural gas to heat their homes and businesses, and natural gas could replace oil for power (electricity) generation. While natural gas production will create environmental impacts, these impacts would be at a somewhat lesser degree because natural gas will not produce oil spills. Other transportation fuels (e.g., propane) may replace some of the oil refined for transportation fuels, and hybrid engines in automobiles (gasoline and batteries) could become more common in the future. The

substitution mix will depend on future technical advances and economic conditions. At this time, no single alternative fuel appears to be able to replace refined oil products.

IV.B.3.e. Other Substitutes.

The Federal Government could impose regulations mandating substitutes for oil. The most likely sector to target would be electricity generation. The reader is referred to the paper *Energy Alternatives and the Environment* (USDOI, MMS, 2001a). Economic conditions will ultimately define the most efficient and cost effective alternatives for energy and fuel consumption.

IV.C. Analysis of Effects of Chukchi Sea Oil and Gas Development.

IV.C.1. Alternative I – Proposed Action.

IV.C.1.a. Water Quality.

This section assesses the possible/probable impacts associated with oil and gas exploration activities on the OCS areas designated as the Chukchi Sea, as well as State waters contiguous with the selected OCS areas (Map 1). Water quality is a term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose. A waterbody in its natural state is free from the harmful effects of human-generated pollution, habitat loss, and other negative stressors. It is characterized by biological diversity and abundance. To develop the impact assessment to water quality, we considered the assessment scenario (Sec. IV.A.2), the impacts associated with those activities described within the scenario (Table IV.A-1), and historical trends in the regulatory compliance and industry.

IV.C.1.a(1) Existing Water Quality. The Arctic Region of the Alaska OCS contains the Beaufort Sea, the Hope Basin, and the Chukchi Sea Planning Areas. The general water quality of the OCS is relatively unspoiled due to its remoteness, the limited presence of human (anthropogenic) pollution, and healthy ecological system. Industrial impacts are minimal, with degradation of water quality primarily confined to external intrusions and naturally occurring processes. Declines in water quality, where they occur, are largely related to seasonal biological activity and naturally occurring processes, such as formation of surface ice, seasonal plankton blooms (occurring primarily in spring and fall), naturally occurring oil/hydrocarbon seeps, seasonal changes in water turbidity due to terrestrial runoff, and localized upwelling of cold water. Chukchi Sea water quality is well within the U.S. Environmental Protection Agency (USEPA) criteria for the protection of marine life; and the majority of the water flowing into the Alaska arctic marine environment is not subject to human activity or stressors and is considered unimpaired). There are no Federal Clean Water Act Section 303(d) impaired waterbodies identified within the Arctic Region by the State of Alaska (ADEC, 2004).

The water quality of the Sale 193 area is generally pristine; detectable pollutants occur at very low levels in the waters and/or sediments and do not pose an ecological risk to marine organisms (USDOI, MMS, 2003a). These impurities are proportionally introduced into the marine environment through inflow from the Bering Sea, river runoff, and coastal erosion. The rivers that flow into the Sale 193 area remain relatively unpolluted by human activities.

IV.C.1.a(2) Water Quality Criteria. The USEPA's Ocean Discharge Criteria (40 CFR 125, Subpart M) sets forth specific determinations of unreasonable degradation that must be made prior to USEPA approving permit actions. Unreasonable degradation of the marine environment is defined (40 CFR 125.121[e]) as follows:

- Significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities;
- threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms; or
- loss of aesthetic, recreational, scientific, or economic values, which are unreasonable in relation to the benefit derived from the discharge.

Impacts determination to water quality resulting from marine discharges is made based on consideration of the following 10 criteria (40 CFR 125.122):

- The quantities, composition, and potential for bioaccumulation or persistence of the pollutants to be discharged.
- The potential transport of such pollutants by biological, physical, or chemical processes.
- The composition and vulnerability of the biological communities that may be exposed to such pollutants, including the presence of unique species or communities of species, the presence of species identified as endangered or threatened pursuant to the Endangered Species Act, or the presence of those species critical to the structure or function of the ecosystem, such as those important for the food chain.
- The importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery/forage areas, migratory pathways, or areas necessary for other functions or critical stages in the lifecycle of an organism.
- The existence of special aquatic sites including, but not limited to, marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas, and coral reefs.
- The potential impacts on human health through direct and indirect pathways.
- Existing or potential recreational and commercial fishing, including finfishing and shellfishing.
- Any applicable requirements of an approved Coastal Zone Management Plan.
- Such other factors relating to the effects of the discharge as may be appropriate.
- Marine water quality criteria developed pursuant to Section 304(a)(1).

Federally promulgated water quality standards adopted by the State of Alaska regarding toxic substances, including human health criteria and aquatic life criteria, are found at 40 CFR 131.36. The Alaska water quality regulations are found within 18 AAC 70. The *Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances*, dated May 15, 2003, constitute the water quality standards regulating human activities that result in alterations to waters within the State's jurisdiction. An effluent discharged to State or Federal water may not impart chronic toxicity to aquatic organisms, expressed as 1.0 chronic toxic unit, at the point of discharge or, if the regulatory agency(s) authorizes a mixing zone in a permit, approval, or certification, at or beyond the mixing zone boundary, based on the minimum effluent dilution achieved in the mixing zone. If the agency(s) determines that an effluent has reasonable potential to cause or contribute to exceeding the whole effluent toxicity limit, the agency(s) will require whole effluent toxicity testing as a condition of a permit, approval, or certification.

IV.C.1.a(3) Impacts Relating to Oil and Gas Postlease Activities. Oil and gas drilling generates a wide range of waste materials related to the drilling process, equipment operations and maintenance, and personnel housing. The proportions and amounts of discharged wastes can change considerably during the lifecycle of postlease exploration to development and operations activities. The major discharges to marine waters associated with postlease activities correspond to discharges with the greatest volumes and amounts of pollutants. The major waste streams from drilling operations are drilling fluids, also called drilling mud, and drilling cuttings due to their volume and composition. During the production phase, produced waters are the largest waste streams generated. Under normal petroleum extraction, formation water and brine are extracted, making up the majority of produced liquids requiring managed reuse or disposal. Produced waters include formation water, brine, injection water, and other production and operationally generated liquids. These waters contain dissolved minerals and soluble fractions of the crude oil. Produced waters may need to be cleaned before they are disposed of. The remaining waste streams resulting from oil and gas exploration/development operations may be termed as miscellaneous waste. These are waste streams that are generated in relatively small volume and contain low pollutant levels, yet are significant enough to be of regulatory concern.

A wide range of water quality degradation could occur as a result of oil activities associated with Sale 193. Degradation could result from nonpoint source and point source discharges; construction activities; normal operational activities; and accidental hydrocarbon discharges due to spills, blowouts, noncompliant operational activities and/or permitted processes, and chronic small-volume spills.

IV.C.1.a(4) Discharges.

IV.C.1.a(4)(a) Drilling Muds and Cuttings. All kinds of drilling wastes are associated with oil and gas drilling, including drilling muds and cuttings. Drilling wastes deserve special attention. The volume of drilling wastes usually ranges from 1,000-5,000 cubic meters (m³) for each well. Such wells can number into dozens for one production facility and many hundreds for a large field.

The discharge rate of drilling fluids (muds) and cuttings during well-drilling operations is quite variable. The volume of rock cuttings produced from drilling primarily is a function of the depth of the well and the diameter of the wellbore. Drilling fluid is an important component in the drilling process. Fluid in the wellbore (1) cools and lubricates the drill bit; (2) removes the rock fragments, or *drill cuttings*, from the drilling area and transports them to the surface; (3) counterbalances formation pressure to prevent formation fluids (i.e., oil, gas, and water) from entering the well prematurely; and (4) prevents the open (uncased) wellbore from caving in (Berger and Anderson, 1992; Souders, 1998). Different properties may be required of the drilling fluid, depending upon the drilling conditions. For example, a higher-density fluid may be needed in high-pressure zones, and a more temperature-resistant fluid may be desired in high-temperature conditions.

While drilling fluid may be a gas or foam, liquid-based fluids (called drilling muds) are used for approximately 93% of wells (American Petroleum Institute [API], 1997). Drilling muds usually contain bentonite clay, which increases the viscosity and alters the density of the fluid. Drilling mud also may contain additional additives that alter the properties of the fluid. The API environmental guidance document *Waste Management in Exploration and Production Operations*, (API E5) considers the three general categories of drilling muds to be water based, oil based, and synthetic based. Synthetic-based muds are used as substitutes for oil-based muds but, in some situations, may be an advantageous replacement for water-based muds.

Water-based muds are used most frequently. The base is saltwater for offshore wells. The primary benefit of water-based muds is cost; they are the least expensive of the major types of drilling fluids and generally are less expensive to use, because the resultant drilling waste can be discharged onsite provided they pass regulatory requirements (USEPA, 1999). The significant drawback with water-based muds is their limited lubricity and reactivity with some shales. In deep holes or high-angle directional drilling, water-based muds cannot supply sufficient lubricity to avoid sticking of the drill pipe. Reactivity with clay shale can cause the destabilization of the wellbore. In these cases, oil-based and synthetic-based muds are needed.

Drilling muds typically have several additives. The following lists the more significant and/or widely used industrial additives:

- Weighting materials, primarily barite (barium sulfate), may be used to increase the density of the mud to equalize the pressure between the well bore and formation when drilling through particularly pressurized zones. Hematite (Fe₂O₃) sometimes is used as a weighting agent in oil-based muds (Souders, 1998).
- Corrosion inhibitors such as iron oxide, aluminum bisulfate, zinc carbonate, and zinc chromate protect pipes and other metallic components from acidic compounds encountered in the formation.
- Dispersants, including iron lignosulfonates, break up solid clusters into small particles so they can be carried by the fluid.
- Flocculants, primarily acrylic polymers, cause suspended particles to group together so they can be removed from the fluid at the surface.
- Surfactants, like fatty acids and soaps, defoam and emulsify the mud.
- Biocides, typically organic amines or formaldehydes, kill bacteria that may produce toxic hydrogen sulfide gas.
- Fluid-loss reducers, including starch and organic polymers, limit the loss of drilling mud to underpressurized or high-permeability formations (USEPA, 1987).

Drill cuttings are removed from drilling muds and cleaned in special separators. The amount of oil left on cuttings after cleaning is reduced, but still detectable, and has been found to be much higher when oil-based fluids are used. Separated drilling muds and cleaning fluids used to treat cuttings are partially returned to

the drilling equipment circulating system. Drill cuttings separated from drilling muds have a complex and extremely changeable composition. This composition depends on the type of rock, drilling regime, formulation of the drilling fluid, technology to separate and clean cuttings, and other factors. However, in all cases, drilling muds play the leading role in forming the composition of drill cuttings. No precise, standard formulation exists for drilling muds. Their composition depends on the needs of the particular situation. At present, the two main types of drilling fluids used in offshore drilling are based either on crude oil, oil products, and other mixtures of organic substances (diesel, paraffin oils, etc.) or on water (freshwater or seawater with bentonite, barite, and other components added). During the last 10 years, preference is given to using the less-toxic water-based drilling muds. However, in some cases—during drilling of deviated wells through hard rock—using oil-based fluids is still inevitable. The oil-based fluids, in contrast with the water-based ones, usually are not discharged overboard after a single application; they are regenerated and included in the technological circle. Synthetic-based muds are the third category of drilling fluids and are based on the products of chemical synthesis with ethers, esters, olefins, and polyalphaolefins (Burke and Veil, 1995). Such drilling fluids allow highly deviational or horizontal drillings to be conducted. From the environmental perspective, the most important fact is that they have low toxicity as compared with other drilling formulations. Despite the relatively high cost of synthetic-based drilling muds, their technological and environmental advantages open wide possibilities for their effective use in oil and gas production.

A recently developed technology to manage wastes, especially mud/drilling cuttings and produced water, allows them to be reinjected into a geological formation for disposal. This would remove and eliminate these waste streams as a potential source of water quality degradation. The exploration and development scenario presupposes that 80% of the drilling mud would be reconditioned and reused. All waste products (drilling muds, rock cuttings, and produced water) for on-platform wells would be treated and then disposed of in shallow wells on the production platform. Some other measures (such as slim-hole drilling) to reduce discharges, particularly in environmentally sensitive locations, are being investigated by industry. These management methods will allow a reduction or elimination of the need to discharge drill cuttings, produced waters, and some other generated wastes to marine waters, minimizing or eliminating associated impacts to water quality.

On discharge, much of the discharged drilling muds and cuttings will reach the seafloor within a few hundred meters from the drilling platform. The thickness of the cuttings pile would decrease with distance from the platform. Finer materials, (e.g., barite and clays) associated with the cuttings, may extend farther out from the platform. Possible effects on benthic communities are discussed in Section IV.C.1.c(3)(a)2). The subsequent fate of the upper and lower plumes will depend primarily on the physical processes (discussed in Sec. III.A.5) that dilute, resuspend, and transport particulates or entrain them into the sediments. These impacts typically include localized degradation in dissolved oxygen (DO), total suspended solids (TSS), pH, light penetration, and contaminant concentrations. The TSS may increase dramatically due to the entrainment of fine material in the water column. A plume typically forms whereby material may be advected short distances from the disposal site. A reduction in DO is typical as common constituents of sediments are oxidized and organic material is metabolized by microbial activity at the sediment-water interface. Typically, the impact to water quality from dredged-material disposal is short-term. Conditions typically return to ambient conditions within hours to days, depending on the amount, composition, and frequency of the disposed material.

IV.C.1.a(4)(b) Produced Waters. Produced waters usually include dissolved salts and organic compounds, oil hydrocarbons, trace metals, suspensions, and many other substances that are components of formation water from the reservoir or are used during drilling and other production operations. Produced waters can pick up additional substances, if they are mixed, or come into contact with the extracted oil, gas, or intended injection waters from the wells. The discharge volume of produced waters could dominate considerably over other oil and gas generated wastes for the lifetime of the project. Produced waters include formation water, brine, injection water, and other production and operationally generated liquids. Formation water and brine are extracted along with oil and gas. These waters contain dissolved minerals and soluble fractions of the crude oil. These waters need to be cleaned before they are discharged into the sea. Special separation units are typical practices used for oil separation of industrial liquid wastes. The oil separators mainly remove particulate and dispersed oil, while dissolved hydrocarbons in concentrations from 20 milligrams per liter (mg/L) to greater than (>)50 mg/l go overboard as part of the discharged waters (Somerville et al., 1987; GESAMP, 1993). The volumes of such discharges could reach thousands

of tons of formation water generated a year. Depending on its quality, the produced water is either discharged into the sea (regulated by a NPDES permit) or injected into the disposal well (regulated by a USEPA or State injection-discharge permit). Sometimes the oil-water mixtures are transported along the pipelines to onshore separation units.

Over the life of the field, the volume of formation waters produced is equal to 20-150% of the oil-output volume (Collins et al., 1983). As oil is pumped from a field, the ratio of water to oil being produced increases. Toward the end of the production life of a field, 10 barrels (bbl) of water may be produced for every barrel of oil. On this basis, the production of formation waters over the life of the field has been estimated at 2.4-43 Bbbl. Over the life of the field, the mass equivalent of about 12-29 Bbbl of oil would be contained in produced waters.

Treated formation waters may be discharged into the open ocean, reinjected into the oil-producing formation to maintain pressure, or reinjected into underground disposal wells. Discharge of formation waters to marine waters would require a NPDES permit and would be regulated so that water quality criteria, outside an established mixing zone, would not be exceeded.

The major constraint to underground injection is finding a formation at shallow depth that (1) has a sufficiently high permeability to allow large volumes of water to be injected at low pressure and (2) can contain the water. Water cannot be injected into a formation that might otherwise be a future potable-water supply (which precludes the OCS and much of the coastal areas).

If formation waters were reinjected or injected into different formations, no discharges of formation waters would occur and no negative effect on water quality would occur. If formation water discharges were permitted and compliant, the resulting impacts to water quality would depend on the duration of the discharge and the degree/concentration of contamination; the effect on water quality typically would be local impacts. The effect on local water quality to the Sale 193 and adjacent areas is expected to be very low.

IV.C.1.a(4)(c) Construction Activities. Sediment resuspension and bottom disturbances are likely to occur as a result of siting platforms, creation of artificial islands, and trenching and burying subsea pipelines. The amount of disturbance associated with platform siting, anchor setting, and drilling would be minimal and restricted to the area immediately adjacent to the activity. Sediment levels likely would be reduced to background levels within several hundred meters downcurrent.

About 10-50 mi of infield flowlines are proposed, along with 30-150 mi of possible pipeline to landfall. The pipelines would have to be anchored or placed in a dredged trench during summer and possibly fall. Trenching would disturb 946 hectares (9.46 km²) of ocean bottom in the Chukchi Sea. Dumping of dredged spoils would disturb an additional 1,892 hectares (18.92 km²) in the Chukchi Sea, or somewhat less if the spoils were used to backfill the trench. Total volume of fill material would be 28,000,000 m³.

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. The sea bottom over the sale area within 80 km of shore is mostly sand; farther from shore, the bottom is mostly mud (Lewbel, 1984). Turbidity typically would extend perhaps 3 km from trenching and dumping operations.

Experiences with actual dredging or dumping operations elsewhere offshore of Alaska and in other U.S. waters show a decrease in the concentration of suspended sediments with time (2-3 hours) and distance (1-3 km) downcurrent from the discharge. In dredging operations associated with artificial-island construction and harbor improvements in the mostly sandy sediments of the Canadian Beaufort Sea, the turbidity plumes tended to disappear shortly after operations ceased. Plumes generally extended from a few hundred meters to a few kilometers (Pessah, 1982). Because dredging occurs at a rate of up to 2 km/day, the extent of the turbidity plumes would be about 6 km at any one time (a 1-km x 3-km area).

Prior to any discharge of dredge or fill material into U.S. waters, permits and approval from State and Federal regulatory agencies would be required; with associated followup project-specific environmental assessment process and documentation as required. Effects on water quality from dredging (and dumping)

are expected to be local and short term. Effects on local water quality are expected to be low, while regional effects are expected to be very low.

IV.C.1.a(4)(d) Miscellaneous Discharges. There are three associated drilling-waste-stream discharges that are a relatively small but notably significant category of waste from the oil- and gas-extraction industry: deck drainage, sanitary waste, and domestic waste. Because of their nature, these waste streams are the most likely to contain constituents of concern. The following paragraphs provide a discussion of each of these discharges.

IV.C.1.a(4)(d)1) Deck Drainage. Deck drainage refers to any waste resulting from platform washing; deck washing; spillage; rainwater; and runoff from curbs, gutters, and drains, including drip pans and wash areas. This also could include pollutants, such as detergents used in platform and equipment washing, oil, grease, and drilling fluids spilled during normal operations.

Deck drainage occurs when water from rainfall or from equipment cleaning comes in contact with oil-coated surfaces; the water becomes contaminated and must be treated and disposed. Oil and grease are the primary pollutants identified in the deck drainage waste stream (USEPA, 1993a). In addition to oil, various other chemicals used in drilling operations may be present in deck drainages. The chemicals may include drilling fluids, ethylene glycol, lubricants, fuels, biocides, surfactants, detergents, corrosion inhibitors, cleaners, solvents, paint cleaners, bleach, dispersants, coagulants, and any other chemical used in the daily operations of the facility (Kramme, 1985).

The major factors in the performance of control and treatment technology are salt content, solid content, chemical content, oil content, temperature, oil density, oil viscosity and wax content, and oil-droplet size (USEPA, 1993a). A typical facility is equipped with drip pans and gutters to collect deck and drilling-flow drainage. The drainage is collected in a sump where the water and oil are separated by a gravity separation process. Oil in the sump tank is recovered and transferred to shore via pipeline or reinjected to the formation. The water from the sump is discharged to the ocean via a skim pile.

Deck-drainage discharges are not continuous discharges and they vary significantly in volume. At times of platform washdowns, the discharges are of relatively low volume and are anticipated. During rainfall, very large volumes of deck drainage may be discharged in a very short time period. Deck drainage is a concern particularly in areas with high precipitation; however, the low arctic temperatures prevent high volumes of deck drainage due to the prolonged winter months, and precipitation drainage is expected to occur only during the open-water (summer) months. While it is expected that only small quantities (<300 gallons per day [gpd]) of deck drainage would occur during the effective period of this assessment, it is possible that higher quantities (~75,000 gpd) may occur as shown by past discharges.

IV.C.1.a(4)(d)2) Sanitary and Domestic Waste. While some platforms discharge sanitary and domestic wastes separately, many combine these waste streams prior to discharge. Therefore, we discuss sanitary waste and domestic waste as combined waste. Sanitary waste is human body waste discharged from toilets and urinals. It consists of secondary treated chlorinated effluent. Domestic waste (gray water) refers to materials discharged from sinks, showers, laundries, safety showers, eyewash stations, and galleys. Gray water can include kitchen solids, detergents, cleansers, oil, and grease. Domestic waste also includes solid materials such as paper and cardboard, which must be disposed of properly.

The concentration of sanitary wastes varies widely with time, occupancy, platform characteristics, and operational situation. Pollutants of concern in untreated sanitary waste include DO, TSS, coliform, and residual chlorine. Typical concentrations of these pollutants in treated effluent are 30 mg/L, 40 mg/L, 180 colonies/100 milliliters (mL), and 1.7 mg/L, respectively (USEPA, 1993a).

There are two alternatives to handling of sanitary wastes from offshore facilities. The wastes can be treated at the offshore location, or they can be retained and transported to shore facilities for treatment. Because of the remote areas of operation and storage limitations, most offshore facilities usually treat and discharge sanitary wastes at the source. The treatment systems presently in use may be categorized as physical/chemical, and biological.

IV.C.1.a(5) Regulatory Protection of Water Quality.

National Pollutant Discharge Elimination System. The USEPA has the regulatory authority to regulate industrial and municipal discharges of pollutants to surface waters in the Pacific Northwest and Alaska under NPDES. Offshore wastes from exploration activities may be discharged overboard in accordance with the NPDES general permit. Development and production activities will require an individual NPDES permit issued to the operator by the USEPA Region 10 program office, which will specifically identify discharge allowances and required operational practices for each facility covered under an individual permit.

Section 402(p)(4) of the Clean Water Act (CWA) clarifies the requirement for USEPA and delegated State agencies to issue NPDES permits for surface water discharges associated with industrial activity.

Section 403 of the CWA requires that an NPDES permit for a discharge into marine waters located seaward of the inner boundary of the territorial seas (i.e., State and Federal offshore waters) be issued in accordance with guidelines for determining the potential degradation of the marine environment. These guidelines, referred to as the Ocean Discharge Criteria (40 CFR 125, Subpart M), and section 403 of the CWA are intended to “prevent unreasonable degradation of the marine environment and to authorize imposition of effluent limitations, including a prohibition of discharge, if necessary, to ensure this goal.” (49 *FR* 65942, October 3, 1980).

In general, the CWA requires that the effluent limits for a particular pollutant be the more stringent of either technology-based limits or water quality based limits. A technology-based effluent limit requires a minimum level of treatment for point sources based on currently available treatment technologies.

A water quality-based effluent limit is designed to ensure that the water quality standards of a waterbody are being met.

Alaska Water Quality 18 AAC 70. For Alaska, the State water quality standards are found at Title 18, Chapter 70 of the Alaska Administrative Code. The applicable criteria are determined based on the beneficial uses of the receiving water. The beneficial uses for the coastal areas of the Beaufort and Chukchi seas are aquaculture water supply; seafood-processing water supply; industrial water supply; contact and secondary recreation; growth and propagation of fish, shellfish, other aquatic life, and wildlife; and harvesting for consumption of raw mollusks or other raw aquatic life. For any given pollutant, different uses may have different criteria. To protect all beneficial uses, the State permit limits are based on the most stringent of the water quality criteria applicable to those uses.

The State of Alaska’s water quality standard that require that State waters must not receive floating solids, debris, sludge, deposits, foam, scum, or other residues of any kind in concentrations causing nuisance, objectionable, or detrimental conditions or that make the water unfit or unsafe for the use. This standard is also being applied to discharges within Federal waters to ensure compliance with the Coastal Zone Management Act (CZMA). Operators have been subject to this requirement in previous NPDES permits, and past practices have not resulted in violations.

Federal water quality regulations allow a 100-m-radius mixing zone for initial dilution of effluent. At the edge of the mixing zone, acute (1-hour average concentration) water quality criteria must be met. Acute criteria are applicable to instantaneous releases or short-term discharges of pollutants such as drilling mud discharges. Direct estimates or measurements of total recoverable concentrations of metals in discharged drilling muds are not available. The dissolved concentrations of all trace metals considered by the USEPA to be the best estimator of the total recoverable concentration are below the acute marine-water quality criteria, at 100 m from the discharge point. Long-term leaching of metals from deposited muds would be slight and no water quality criteria are expected to be violated (54 *FR* 13296-13305).

The USEPA receives compliance reports from the lessees if data gathered through permit-discharge monitoring indicate that continued discharge may cause unreasonable degradation, the discharge shall be halted by MMS and/or regulatory notification, or additional discharge limitations established.

Coastal Zone Management Program. The OCS seaward of the State's 3-mi limit in Federal waters is a "geographic location description" for purposes of Federal consistency reviews under 15 CFR 930.34(b) and 930.53(a). A Federal activity on the OCS that causes effects on any Alaskan coastal use or resource, as the term "effects" is defined in the CZMA at 15 CFR 930.11(g), must be consistent with the Alaska Coastal Zone Management Program (ACZMP). The State of Alaska reviews OCS Exploration Plans (EP's) and Development and Production Plans (DPP's) to determine whether the proposed activities are consistent with the ACZMP (see also Sec. IV.C.1.o). All EP's and DPP's submitted to MMS for postlease activities receive an ACZMP review and determination of consistency with the ACZMP. Impacts and effects on water quality and correspond/relating ancillary media and receptor are of central interest in an ACZMP review and determination. The MMS may not issue a permit for activities described in a plan unless the State concurs.

U.S. Army Corps of Engineers Ocean Discharge Permit 404(b). Section 404 of the CWA requires permits for the discharge of "dredge or fill material" into "waters of the United States." Unlike the rest of the CWA, the permit aspects of Section 404 are administered by the U.S. Army Corps of Engineers (Corps) using the USEPA for environmental guidance. The Corps issues Section 404 permits but must abide by USEPA guidelines, and the USEPA has the power to veto a permit the Corps issues.

The Corps' regulatory authority for discharges to navigable waters is contained in Section 10 (33 U.S.C. 403), which covers construction, excavation, or deposition of materials in, over, or under such waters, or any work which would affect the course, location, condition, or capacity of those waters. In 1972, amendments to the Federal Water Pollution Control Act added what is commonly called Section 404 permitting authority (33 U.S.C. 1344) to the program. The Secretary of the Army, acting through the Chief of Engineers, is authorized to issue permits, after notice and opportunity for public hearings, for the discharge of dredged or fill material into waters of the United States at specified disposal sites. Selection of such sites must be in accordance with guidelines developed by the USEPA in conjunction with the Secretary of the Army; these guidelines are known as the 404(b)(1) guidelines.

The basic form of authorization used by the Corps' districts is the individual permit. Processing such permits involves evaluation of individual, project specific applications in what can be considered three steps: (1) preapplication consultation (for major projects), (2) formal project review, and (3) decisionmaking.

If a permit is required for a project on or near Federal lands, there are additional considerations beyond the "public interest" review. The Corps must provide FWS an opportunity to comment on permit applications and must give consideration to any FWS comments. Other statutes, such as the Marine Mammal Protection Act and the Endangered Species Act, also may apply to the Corps' deliberations. Additionally, federally recognized tribes have special standing for consultations of Federal permits.

The laws that serve as the basis for the Corps' regulatory program contain several enforcement provisions that provide for criminal, civil, and administrative penalties. While the Corps is solely responsible for the initiation of appropriate legal actions pursuant to enforcement provisions relating to its Section 10 authority, the responsibility for implementing those enforcement provisions relating to Section 404 is jointly shared by the Corps and USEPA.

IV.C.1.a(6) Oil Spills. For purposes of analysis, it is assumed that one spill of either 1,500 or 4,600 bbl would occur. In addition to a large spill, more chronic spillage of smaller volumes also is estimated. About 179 small crude oil spills totaling 1,214 bbl are estimated to occur over the life of the field.

The more volatile compounds in an oil slick, particularly aromatic volatiles, are usually the most toxic components of the slick. In situ, cold-water measurements (Paine and Levin, 1981, 1982, 1985; Payne et al., 1984a,b) have demonstrated that individual compounds in a slick decrease significantly in concentration in hours to tens of days. Because the bulk of these compounds are lost in <3 days, 3-day trajectories are considered an appropriate length of time to approximate the initially higher toxicity of Alaskan spills. Over the first 10 days of a spill, only about 5% of a slick can be expected to dissolve (Butler, Morris, and Sleeter, 1976, as cited by Jordan and Payne, 1980).

Highest dissolution rates of aromatics from a slick, and accumulation in underlying water, occur in the first few hours of a spill (Paine and Levin, 1981). By the time dissolved oil has worked down 10 m in the water column, it would have been diluted and spread horizontally over about 10,000 m. The slick would have become patchy, with the total area containing widely separated patches of oil being orders of magnitude larger than the actual amount of surface area covered by oil. At sea, the water under a slick changes continuously and aromatics do not continue to accumulate in the same water.

Water-column concentrations of hydrocarbons following spills are difficult to compare to existing State and Federal water quality standards because of ambiguity in the standards. Applicable ambient water quality standards for marine waters of the State of Alaska are the lower of 0.015 ppm total hydrocarbons and 0.010 ppm aromatic hydrocarbons or 0.01 of applicable continuous-flow, 96-hour LC₅₀ for critical lifestages of important local species (ADEC, 1979). Federal standards are set at 0.01 of the applicable LC₅₀; no absolute Federal concentration standard exists for hydrocarbons (USEPA, 1986). The State of Alaska criterion of a maximum of 0.015 ppm of total hydrocarbons in marine waters—about fifteenfold background concentrations—provides the readiest comparison. This analysis considers 0.015 ppm to be a chronic criterion and 1.5 ppm—a hundredfold-higher level—to be an acute criterion.

Major spills generally result in peak, dissolved-hydrocarbon concentrations that are only locally and marginally at toxic levels. The highest concentration observed following the *Argo Merchant* spill was 0.25 ppm, despite the presence of 20% by volume of the more soluble cutting stock (National Research Council, 1985). Volatile liquid hydrocarbons in the *Ixtoc* spill decreased from 0.4 ppm near the blowout to 0.06 ppm at a 10-km distance and to 0.004 ppm at a 19-km distance from the blowout. Similarly, relative and rapid decreases also were found for specific toxic compounds such as benzene and toluene (National Research Council, 1985). Concentrations of volatile liquid hydrocarbons, present mostly as an oil-in-water emulsion, within 19 km of the *Ekofisk Bravo* blowout in the North Sea ranged up to 0.35 ppm (Grah-Nielsen, 1978). Lesser amounts of oil (probably <0.02 ppm) were detectable in some samples, at a 56-km distance, but not at an 89-km distance. In more restricted waters during flat calm, a test spill during the Baffin Island Oil Spill Project resulted in maximum hydrocarbon concentrations in the water column of 1-3 ppm (Green, Humphrey, and Fowler, 1982). These concentrations were reached within 2 hours of the spill and persisted through 24 hours. No oil was detected deeper than 3 m, and the most oil and highest concentrations were in the top meter.

These concentrations of oil in the water column are relatively low because even if a slick were completely mixed into the same watermass through use of chemical dispersants, vertical, and especially horizontal, dispersion and consequent dilution rapidly would decrease hydrocarbon concentrations for all but the largest spills in several hours to a few days after spillage ceases (Mackay and Wells, 1983).

Only a small portion of the oil from a spill would be deposited in the sediments in the immediate vicinity of the spill or along the pathway of the slick. The observed range in deposition of oil in bottom sediments following offshore spills is 0.1-8% of the slick mass (Jarvela, Thorsteinson, and Pelto, 1984).

Generally, the higher percentage of deposition occurs in spills nearshore where surf, tidal cycles, and other inshore processes can mix oil into the bottom. Farther offshore, suspended-sediment loads are low; and only about 0.1% of the crude would be incorporated into sediments within the first 10 days of a spill (Manen and Pelto, 1984).

If the spilled oil were of a composition similar to that of Prudhoe Bay crude, about 68% of the spilled oil could persist as individual tarballs dispersed on the water surface after the slick disappeared. Slow 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 (Bulter, Norris, 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 during the slow process of sinking, individual, sunken tarballs would be widely dispersed in the sediments. The average levels of local or regional contamination in sediments would be insignificant.

Only if oil were mixed into the shoreline and then dispersed offshore could elevated concentrations of hydrocarbons occur locally.

Decomposition and weathering processes for oil are much slower in cold waters than in temperate regions. Prudhoe Bay crude remained toxic to zooplankton in freshwater ponds for 7 years after an experimental spill, demonstrating persistence of toxic-oil fractions or their weathered and decomposition products. In marine waters, advection and dispersion would reduce the effect of any release of toxic oil fractions or their toxic-degradation products, including those from photo-oxidation, except possibly to the isolated waters of embayments or shallow waters under thick ice, or from a fresh spill in rapidly freezing ice.

Peard Bay, the only shallow, isolated embayment within the sale area, would be the most susceptible exception. A spill in Peard Bay during a period of rapid ice growth could leach water-soluble aromatics into the sinking brine waters. In such an area, the mixing of brine waters would be restricted by both topography and the high density of the brine. The brine and any dissolved oil could flow down the bottom of the Barrow Canyon farther offshore and form a thin, intermediate-density layer at about a 100-m water depth. Stability of the stratified watermass would limit dispersion of the dissolved hydrocarbons, and high concentrations (a few parts per million) could be hypothesized to persist for several years. However, oil released under such conditions (rapid ice formation) would freeze into the ice in 5-10 days at most, stopping dissolution and limiting the effect of this freezeup scenario.

The assumed oil spill of $\geq 1,000$ bbl could occur in either the summer or winter seasons. Hydrocarbon concentrations following a summer open-water spill of 1,500 or 4,600 bbl in the Chukchi Sea would be expected to decline rapidly in the first 30 days following the spill. The average hydrocarbon concentration after 3 days in the top 10 m of the water column below the discontinuous slick would be 0.16 ppm. The discontinuous slick would cover 57 km² after 3 days. The average concentration, in the top 10 m of the discontinuous slick, would be expected to be 0.09 ppm after 10 days and 0.04 ppm after 30 days following the spill. The mean area of the discontinuous slick would reach 260 km² after 10 days and 1,100 km² after 30 days.

A spill occurring in the winter season would be frozen in the ice and would move with the ice for the remainder of the winter. Spills in first-year ice would melt out in late spring or early summer. Spills in multiyear ice would melt out later in the summer or in subsequent summers. Spills released from the ice would be relatively unweathered and would have the characteristics of fresh oil. Before the oil was released from the ice, the contaminated ice could drift for hundreds of kilometers. A 1,500 or 4,600-bbl meltout spill in the Chukchi Sea (see Sec. IV.A) would have the following hydrocarbon concentrations: 0.03 ppm after 3 days; 0.05 ppm after 10 days; and 0.04 ppm after 30 days. The discontinuous slick size would cover from 1,400 km² after 3 days to 2,200 km² after 30 days.

Sustained degradation of water quality to levels above State and Federal criteria from hydrocarbon contamination is unlikely. Hydrocarbon concentrations from two oil spills $\geq 1,000$ bbl could exceed the chronic criterion of 0.015 ppm total hydrocarbons on at least several thousand square kilometers for a short period of time. Concentrations above the acute criterion (1.5 ppm) are not anticipated. The persistence of individual oil slicks would be short term (<1 year), but the slick, intact and unweathered in the pack ice, could drift hundreds of kilometers. The 46 small spills <1,000 bbl estimated to occur over the life of the field would result in local chronic contamination. Effects of oil spills on water quality are expected to be low both locally and regionally.

Summary. In the Proposed Action, water quality in the Chukchi Sea maybe affected by discharge of pollution into the marine waters. The discharges may come from point source and nonpoint source discharges, which include exploration and production drilling, deck drainage, platform discharges, construction activities (platform and/or pipeline placement and modifications), operational activities, and/or nonpermitted releases and oil spills.

Discharges of muds and cuttings and produced waters are the major waste streams associated with postlease oil and gas exploration and drilling activities. Drilling muds are generated during drilling operations that may extend for 2-4 months for the exploration phase, and from 3-5 years during the development phase; produced waters are generated as oil and gas is pumped from the formation in the production and operation phase of postlease activities. Other possible impacts are associated with miscellaneous discharges, which include sanitary and domestic waste.

The types of wells that may be drilled under this assessment include exploration wells, delineation wells, and production wells. It is estimated that up to 6 explorations wells, 8 delineation wells, 80-120 production wells, and 20-40 service well will be drilled in the Chukchi Sea Planning Area (Table IV.A-1). Components of concern in drilling fluids include trace metals and specialty additives used with generic and synthetic-based drilling-mud systems. The majority of trace metals will remain bound to particulates in the whole mud. Specialty additives could be a source of trace metals (e.g., zinc) and petroleum hydrocarbons. Mass loadings of the additives depend on the concentrations, frequency of usage, and conditions encountered during the drilling. It is estimated that 2,260 bbl of drilling mud and 7,880 bbl of drill cuttings would be discharged in the Chukchi Sea Planning Area.

The production of formation waters over the life of the field can be estimated between 2.4 and 43 Bbbl. The exploration and development scenario supposes that production slurry (oil, gas, water) will be gathered on the central platform, where gas and water will be separated and the produced water reinjected. Shallow injection wells will handle these wastewaters and treated drill cuttings. Gas recovered with oil production will be used as fuel for the facility or reinjected into the main reservoir to increase oil recovery. If formation waters were discharged into the water column rather than reinjected, the discharge would be regulated and permitted by USEPA. The effect on water quality would be local and would continue for the life of the discharge. The effect on local water quality is expected to be moderate, while the effect on regional water quality is expected to be very low. Effects on water quality from dredging (and dumping) are expected to be local and short term. Turbidity would increase over a few square kilometers in the immediate vicinity of dredging operations only during actual dredging. Effects on local water quality are expected to be low, while the effect on regional water quality is expected to be very low.

Sustained degradation of local and areawide water quality to levels above State and Federal criteria from hydrocarbon contamination resulting from postlease oil and gas activities is unlikely. Hydrocarbon concentrations from the one assumed oil spill $\geq 1,000$ bbl could exceed the chronic criterion of 0.015 ppm total hydrocarbons on at least several thousand square kilometers for a short time period. Concentrations above the acute criterion are not anticipated. Effects of an oil spill on water quality are expected to be low both locally and regionally.

Conclusion. The effect of the base case on water quality as a result of exploration and development and production is expected to be moderate locally and low regionally.

IV.C.1.a(7) Effects from 3D Seismic Surveys. This phase would include 3D seismic surveys using seismic-survey vessel with logistic and icebreaker-support vessels.

Disturbance. Impacts to marine water quality would result from activities corresponding to the seismic-survey vessel and support vessels. This phase would not represent appreciable impacts to the marine water quality due to limited duration of activities and low degree of risk of major discharges. Therefore, direct and/or long term degradation of marine water quality would be unlikely.

IV.C.1.a(8) Effects from Exploration Activities. This phase would include drilling deep test wells using drillships with icebreaker support vessels.

IV.C.1.a(8)(a) Disturbance. Impacts to marine water quality would result from activities corresponding to the exploration platform or support vessels. This phase would not represent appreciable impacts to the marine water quality because of the limited duration of activities and low degree of risk of major discharges. Therefore, direct and/or long-term degradation of marine water quality would be unlikely.

IV.C.1.a(8)(b) Discharges. During the postlease exploration phase of activities, possible impacts to water quality would correspond to permitted discharges to marine waters (point-source); nonpoint-source, disturbance of bottom sediments; generated wastes, and spills and other unpredictable discharges. Survey times will average 20-30 days (with down time) and involve low risk to marine water quality. The probability of a large spill or blowout is almost nonexistent, as is the possibility of a large spill reaching the coast.

Discharges are expected to be minimal and of short duration, and likely would be small quantities of diesel, gasoline, and hydraulic fluids from nonpoint sources and permitted discharges (NPDES AK280000) to

marine waters during exploration activities. Due to potential low quantities of these discharges, impacts on Chukchi marine water quality would be negligible.

IV.C.1.a(8)(c) Small Oil Spills (less than 1,000 barrels). Small spills <1,000 bbl estimated to occur over the life of the field may result in local chronic contamination. Effects of oil spills on water quality are expected to be low both locally and regionally. Sustained degradation of water quality to levels above State and Federal criteria from hydrocarbon contamination is unlikely.

IV.C.1.a(9) Effects from Development Activities. Development activities would start only if a commercially viable quantity of oil is discovered. Oil and gas drilling generates a wide range of waste materials related to the drilling process, equipment operations and maintenance, and personnel housing. The proportions and amounts of discharged wastes can change considerably during the lifecycle of postlease development and operations activities. The major waste streams are drilling fluids, also called drilling mud, and drilling cuttings and production phase produced waters.

IV.C.1.a(9)(a) Disturbance. A wide range of water quality degradation could occur as a result of oil activities associated with the lease sale. Degradation could result from nonpoint-source and point-source discharges; construction activities; normal operational activities; and accidental hydrocarbon discharges due to spills, blowouts, noncompliant operational activities and/or permitted processes, and chronic small-volume spills.

IV.C.1.a(9)(b) Discharges. During the postlease development phase of activities, possible impacts to water quality would correspond to permitted discharges to marine waters (point source), nonpoint-source disturbance of bottom sediments, generated wastes, and spills and other unpredictable discharges. The production of formation waters over the life of the field can be estimated between 2.4 and 43 Bbbl. The exploration and development scenario supposes that production slurry would be gathered on the central platform, where gas and water will be separated and the produced water reinjected. Shallow injection wells will handle these wastewaters and treated drill cuttings. Gas recovered with oil production will be used as fuel for the facility or reinjected into the main reservoir to increase oil recovery. Any discharges into the water column that are not reinjected would be regulated and permitted by USEPA. The effect on water quality would be local and would continue for the life of the discharge. The effect on local water quality is expected to be moderate, while the effect on regional water quality is expected to be very low. Effects on water quality from dredging (and dumping) are expected to be local and short term. Turbidity would increase over a few square kilometers in the immediate vicinity of dredging operations only during actual dredging. Effects on local water quality are expected to be low, while the effect on regional water quality is expected to be very low.

Sustained degradation of local and area wide water quality to levels above State and Federal criteria from hydrocarbon contamination resulting from postlease oil and gas activities is unlikely.

IV.C.1.a(9)(c) Small Oil Spills. Potential for small oil spills would be expected from operational activities at the central facility, collection and delineation lines, pump stations, and to pipelines. Small oil spills originated on offshore pipelines and the hub platform also would be expected. Small spills <1,000 bbl estimated to occur over the life of the field may result in local chronic contamination. Effects of oil spills on water quality are expected to be low both locally and regionally. Sustained degradation of water quality to levels above State and Federal criteria from hydrocarbon contamination is unlikely.

IV.C.1.a(9)(d) Large Oil Spills (greater than or equal to 1,000 barrels). Large oil spills ($\geq 1,000$ bbl) have a low chance of occurrence. Impacts of large spills would be expected to decline rapidly in the first 30 days following the spill. The average hydrocarbon concentration after 3 days in the top 10 m of the water column below the discontinuous slick would be 0.16 ppm. The discontinuous slick would cover 57 km² after 3 days. The average concentration in the top 10 m of the discontinuous slick would be expected to be 0.09 ppm after 10 days and 0.04 ppm after 30 days following the spill. The mean area of the discontinuous slick would reach 260 km² after 10 days and 1,100 km² after 30 days.

IV.C.1.a(10) Effectiveness of Mitigation Measures. The following are mitigation measures that may be incorporated into an MMS approved plan prior to exploration or development activities, when feasible. Environmental regulatory programs and permitted operations mitigate possible impacts by ensuring that

minimum levels of control, restraint, and monitoring are performed. Many State and Federal environmental regulatory programs are required to review and approve/concur much of the MMS postlease project proposals to minimize and mitigate possible negative impacts to resources or the environment.

A pollution-prevention plan to minimize discharges directly into the water would be implemented.

Due to amendments in the OCS Lands Act, strong safety and pollution-prevention regulations, and the use of blowout-prevention equipment installed nowadays on seabed wellheads, the potential for oil spills has diminished greatly. Therefore, possible impacts to water quality would be expected to be low as a consequence of the implementation of these prevention measures.

Prior to the start of drilling operations, the operator must have an MMS-approved oil-spill-response plan (OSRP). Oil-spill response is specifically addressed under 30 CFR 254, Oil Spill Response Requirements for Facilities Located Seaward of the Coast Line. Each operator is required to prepare an OSRP for their facilities. The operator must include in the OSRP an emergency-response-action plan, a worst-case discharge scenario, an inventory of response equipment to support a worst-case discharge response, contractual agreements with oil-spill-removal organizations that provide response services, a dispersant-use plan, an in situ burning plan, and a training- and response-drill plan. This ensures that the required equipment, training, and resources are available and can be deployed in an effective and efficient manner. Therefore, possible impacts to water quality would be expected to be reduced/low as a consequence of the implementation of these prevention measures.

Training and practice drills of booming and skimming operations would be effective means to prevent oil spills from spreading, and assists in recovery efforts.

Underground-injection control is a technology developed to manage oil- and gas-production wastes, especially mud/drilling cuttings and produced water, by reinjection into a geological formation for managed disposal. This would remove and eliminate these waste streams as a potential source of water quality degradation.

The exploration and development scenario presupposes that 80% of the drilling mud will be reconditioned and reused. All waste products (drilling mud, rock cuttings, and produce water) for on-platform wells will be treated and then disposed of in shallow wells on the production platform. Other measures (such as storage onsite/vessel prior to ultimate disposal, slim-hole drilling, and other compliant disposal methods/practices) to reduce discharges, particularly in environmentally sensitive locations, are being investigated by industry.

Gas recovered with oil production will be used as fuel for the facility or reinjected into the main reservoir to increase oil recovery; removing this waste stream from potentially impacting marine waters.

Pipeline leak-detection systems would include using pigs (bullet-shaped devices that slide through pipelines to look for corrosion). Pig runs would be implemented systematically.

Operators are required by regulation to conduct periodic inspections and tests of facility systems such as blowout preventers, valves, and subsea pipelines to ensure they are operating within established limits. Specific training on well-control practices is required for employees assigned to well-control and production-safety duties along with weekly well-control drills. Therefore, possible impacts to water quality would be expected to be low as a consequence of the implementation of these prevention measures.

Detection of small chronic leaks from sub-sea pipelines that are obscured from view by a solid sheet of ice much of the year was identified as a critical element in reducing the size and impact of a potential release to the environment within the Beaufort Sea. This type of technology is applicable to the Chukchi Sea and will help prevent large, undetected oil spills from small chronic leaks under the ice.

IV.C.1.b. Air Quality.

This discussion considers the potential air quality impacts that could result from activities and developments under the Proposed Action. Impacts to air quality would result from the discharge of air

pollutants from industrial equipment associated with support, construction, and production activities. Background material on the existing air quality in the Chukchi Sea is presented in Section III.A.6. Although none of the standard or proposed stipulations and ITL clauses is particularly applicable to air quality, the lessee's compliance with the 1990 Clean Air Act (CAA) would mitigate adverse air quality impacts.

The USEPA would have jurisdiction under the 1990 CAA for air quality throughout the Chukchi Sea Sale 193 area. Lessees would be required to comply with USEPA's requirements, including New Source Performance Standards and Prevention of Significant Deterioration (PSD) regulations, before operating emission sources on the OCS. For sources located within 25 mi of the seaward boundary of the State, the air quality requirements would be the same as if the source were located onshore. The ADEC has jurisdiction for onshore air quality.

The CAA requires USEPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The USEPA uses "criteria pollutants" as indicators of air quality. The six pollutants include lead, nitrogen dioxide, carbon monoxide (CO), particulate matter (PM), sulfur oxides, and ozone (O₃). To protect human health and welfare, NAAQS (40 CFR 50) establish maximum air pollutant levels for these six pollutants that are not to be exceeded (Table III.A-5). The ADEC has imposed similar criteria under the Alaska Ambient Air Quality Standards (18 AAC 50.010) but has added two additional pollutants: reduced sulfur compounds and ammonia. In addition, both agencies have adopted PSD regulations (40 CFR 51, 18 AAC 50.020), which limit allowable increases in pollutant concentrations above an established baseline for nitrogen dioxide, sulfur dioxide (SO₂), and PM. The PSD regulations are intended to limit deterioration of existing air quality in areas with clean, healthy air (i.e., attainment areas).

Attainment areas are divided into Classes I, II, and III. For each attainment area, maximum allowable increases in concentrations above a baseline level are specified for each PSD pollutant. Class I allows the least degradation; there are no Class I areas in or near the sale area. The sale area and surrounding region are designated Class II, which allows some reduction in the air quality. Baseline PSD pollutant concentrations and the portion of the PSD increments already consumed are established for each location by the USEPA and ADEC before issuing air quality permits.

Air pollutants discussed in this analysis include lead, nitrogen oxides (NO_x), CO, PM, SO₂, O₃, and volatile organic compounds (VOC's). Ozone is not emitted directly by any source but is formed in a series of complex photochemical reactions in the atmosphere involving VOC's and NO_x.

Lead is a metal found naturally in the environment as well as in manufactured products. The major sources of lead emissions historically have been motor vehicles (such as cars and trucks) and industrial sources. Due to the phase out of leaded gasoline, lead emissions would not be considered significant for OCS sources. Today, metals processing is the major source of lead emissions to the air. Other stationary sources are waste incinerators, utilities, and lead-acid battery manufacturers.

Nitrogen oxides consist of both nitric oxide and nitrogen dioxide. Nitrogen oxides are 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 VOC's play a central role in the formation of smog. Nitrogen dioxide breaks down under the influence of sunlight, producing nitric oxide and atomic oxygen, which then combine with diatomic oxygen to form O₃ or with VOC's to form various gaseous and particulate compounds that causes the reduced visibility associated with smog. Two major sources of NO_x emissions are transportation vehicles and stationary combustion sources such as electric utility and industrial boilers and engines.

Carbon monoxide is formed by incomplete combustion. It is a problem mainly in areas having a high concentration of vehicular traffic. Other major sources include industrial-size incinerators and engines. High concentrations of CO present a serious threat to human health, because it greatly reduces the capacity of the blood to carry oxygen. Exposure to elevated CO levels can cause impairment of visual perception, manual dexterity, learning ability, and performance of complex tasks

Particulate matter is a mixture of particles that can adversely effect human health, damage materials, and form atmospheric haze that degrades visibility. Particulate matter usually is divided into different classes based on size, ranging from total suspended matter to PM₁₀ (particles <10 microns [μ] in aerodynamic diameter) to PM_{2.5} (particles <2.5 μ). In general, the smallest particles pose the highest human-health risks. Particulate matter includes dust, dirt, soot, smoke, and liquid droplets directly emitted into the air by sources such as factories, power plants, flares, cars, construction activity, fires, and natural windblown dust. Particles formed in the atmosphere by condensation or the transformation of emitted gases such as SO₂ and VOC's also are considered PM.

Sulfur dioxide is formed in the combustion of fuels containing sulfur. In the atmosphere, SO₂ slowly converts to sulfate particles. High concentrations of SO₂ affect breathing and may aggravate existing respiratory and cardiovascular disease. Sensitive populations include asthmatics, individuals with bronchitis or emphysema, children, and the elderly. Sulfur dioxide also is a primary contributor to acid rain, which causes acidification of lakes and streams and can damage trees, crops, historic buildings, and statues.

Volatile organic compounds are defined by the CAA as chemicals that participate in forming O₃, which is a respiratory toxicant. The class of VOC's includes many specific chemicals that also may cause adverse health effects in their own right (such as cancer or reproductive toxicity). Volatile organic compounds are emitted from diverse sources, including automobiles, chemical-manufacturing facilities, drycleaners, paint shops, and other commercial and industrial sources, especially solvents and paints and oil spills. Emissions of VOC's form O₃ through complex chemical reactions with oxides of nitrogen in the presence of sunlight.

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. The air quality effects of each phase are summarized below. 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).

IV.C.1.b(1) Effects Common to All Alternatives.

IV.C.1.b(1)(a) Discharges (Air Emissions) from the Exploration Phase. For the exploration phase, emissions would be produced by the following:

- vessels used for seismic and other geological and geophysical surveys;
- diesel power-generating equipment needed for drilling exploratory and delineation wells;
- tugboats, supply boats, icebreakers, crew boats, and helicopters used in support of drilling activities; and
- intermittent operations such as mud degassing and well testing.

Pollutants generated would consist primarily of NO_x, CO, and SO₂. We assume that exploration activity would begin in the year following the sale.

We assume that up to four seismic surveys could be conducted during each open-water season. Seismic surveys in the Chukchi Sea probably would be coordinated with surveys in the Beaufort Sea to use the same vessels. Typical seismic survey operations would consist of a large seismic vessel towing airguns and cable arrays and a smaller support boat. Survey times likely would average 20-30 days (with down time) to cover a likely survey area of 200 mi².

Drilling operations would be expected to range between 30 and 90 days at different well sites, depending on the depth to the target formation, difficulties encountered during drilling, and logging/testing operations. Because of the relatively short open-water season in the Chukchi (July-October), we would expect only one

to two exploration wells drilled each drilling season. Five exploration wells have been drilled to date on the Chukchi shelf, and we assume that 7-14 additional wells will be needed to discover and delineate the first commercial field.

IV.C.1.b(1)(b) Discharges (Air Emissions) from the Development and Production Phase. For the development phase, including temporary construction operations and drilling, the main sources of emission offshore would be from:

- gas turbines used to provide power for drilling;
- production equipment, including boilers, heaters, and storage tanks;
- reciprocating engines used for electrical power, including rig generator (during construction phase only; standby only during commissioning);
- heavy construction equipment used to install facility and pipelines;
- construction- and commissioning-support equipment, including cranes, pumps, generators, compressors, piledrivers, welders, heaters, and safety flares; and
- tugboats (needed to move equipment and supply barges), support vessels, and helicopters.

For all these operations, the best available control technology would be applied if emissions for the project were determined to exceed PSD Class II limits under USEPA or ADEC air quality regulations. The main emissions would be NO_x and CO, with lesser amounts of SO₂, VOC's, and PM.

Emissions from development under the Proposed Action would be from the installation of one central platform with processing facilities, construction of up to 150 mi of offshore pipeline, drilling of between 80 and 120 production wells and 20 and 40 service wells, installation of an onshore support facility and pump station, and constructions of up to 300 mi of onshore pipeline stretching eastward to the Trans-Alaska Pipeline System. In the peak years, a probable maximum of 20 wells per year would be drilled from two rigs, one on the platform and the other on a drillship. Peak-year production emissions would result from combined drilling operations and production operations producing about 200,000-250,000 bbl of oil per day and from transportation of that oil. See Section IV.A.1 and Table IV.A-1 for more details of the projected infrastructure.

For the production phase, the main source of offshore emissions would be from turbines used for power generation, gas compression, oil pumping, and water injection. Another source of emissions would be evaporative losses of VOC's from oil/water separators, tanks, pumps, compressor seals, and valves. Reduction in VOC emissions would be achieved by equipping produced water and slop-oil tanks with vapor-recovery systems and using valves and seals designed to prevent VOC leakage. Volatile organic compounds would also be emitted if there were an accidental release of gas (venting). Operators would be required to have a safety flare to safely burn any unexpected releases of natural gas. Flaring gas would be done for safety purposes; but it also would eliminate most of the VOC's, although some emissions of NO_x, carbon dioxide, SO₂, and PM would be released.

Abandonment of facilities after production is no longer viable would require heavy equipment, trucks, and barges, which would emit pollutants at levels comparable to the initial construction phase. Because abandonment operations would last a short time and include no activities that would affect air quality more significantly than previous phases, we conclude that abandonment operations would cause insignificant effects on air quality.

Other sources of pollutants related to OCS operations are accidents such as blowouts and oil spills. Typical emissions from such accidents consist primarily of VOC's; only fires associated with blowouts or oil spills produce other pollutants (see Sec. IV.C.1b(2) on the effects of oil spill below).

The level of emissions under the Proposed Action would be roughly comparable to magnitude of emissions analyzed for Beaufort Sea Sale 144 (USDOJ, MMS, 1996a). The projected production for Sale 193 is approximately 1 Bbbl, compared with 1.2 Bbbl for Sale 144. The peak production rate is 91.2 MMbbl per year, compared with 101 MMbbl per year for Sale 144. The number of production wells drilled each year would be 20 wells for Chukchi Sea Sale 193 compared to 54 production wells each year for Sale 144. Thus, the overall impacts from a Chukchi Sea sale likely would be similar, if not somewhat lower, than the

impacts predicted from the analysis for Sale 144. Air modeling conducted for Sale 144 shows that nitrogen dioxide had the highest concentration of the modeled pollutants, and that all pollutant contributions would be well within PSD Class II limits and NAAQS (USDOJ, MMS, 1996a). Table IV.B.12-1 of the Sale 144 Final EIS (USDOJ, MMS, 1996a) lists estimated uncontrolled pollutant emissions for the peak-exploration, peak-development, and peak-production years from that sale's proposed action. The information and air-modeling results for Sale 144 are incorporated by reference in this analysis.

We also reviewed the air quality analyses performed for the proposed Liberty project in the Beaufort Sea. While Liberty would have lower oil throughput than anticipated under the Sale 193 development scenario, the air quality analysis for the Liberty project is helpful in understanding the likely effects from Sale 193. For Liberty, the highest predicted concentrations for nitrogen dioxide, SO₂, and PM₁₀ occurred within 200 m of the facility boundary and were close to PSD Class II increments (USDOJ, MMS, 2002). The highest onshore concentrations would be considerably less because of their dispersion over distance. The combined facility concentrations for Liberty plus background were well within NAAQS (between 2% and 30% of the standards).

Finally, we considered the effect on air quality from the most significant sources of industrial emissions in the Alaska Arctic, the Prudhoe Bay/Kuparuk/Endicott oil-production complex. The 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 Federal and State ambient air quality standards. The results appear to demonstrate that ambient pollutant concentrations from oil and gas development, even for sites subject to maximum concentrations, would meet the ambient air-pollution standards. This is true even if we assume the baseline PSD concentrations (determined on a site-specific basis) to be zero, limiting the allowable increase in concentrations.

Summary and Conclusion for Effects of Discharges on Air Quality. The air quality analysis is based on the specific emission controls and emission limitations that the operators would apply to meet the appropriate USEPA regulations and permit requirements for any development and production activities. The effects of all these activities would cause only small, local, and temporary increases in the concentrations of criteria pollutants. Because the Proposed Action would have impacts that are comparable or lower than those predicted for Sale 144, and less than the existing Prudhoe Bay/Kuparuk/Endicott oil-production complex, we conclude that the release of criteria pollutants would remain well within PSD limits and NAAQS. Consequently, we consider the effect on air quality to be low.

IV.C.1.b(2) Oil Spills.

IV.C.1.b(2)(a) Effects of Oil Spills on Air Quality. Sources of air pollutants related to OCS operations include emissions from accidental releases of oil or gas. Small accidental crude oil spills would cause minor, localized increases in concentrations of VOC's due to evaporation of the spill. Most of the air emissions would occur within a few hours of the spill and would decrease drastically after that period.

Large spills would result in air emissions over a large area and a longer period of time. Large spills could occur from a well facility or pipeline. Hanna and Drivas (1993) modeled the emissions of various hydrocarbon compounds from a large spill; they examined the rate of evaporation and ambient concentrations of 15 different VOC's. A number of these compounds, including benzene, ethylbenzene, toluene, and o-xylenes, are classified by USEPA as hazardous air pollutants. The results showed that these compounds vaporize almost completely within a few hours after a spill. Ambient concentrations peak within the first several hours after a spill and are reduced by two orders of magnitude after about 12 hours. The heavier compounds take longer to vaporize and may not peak until about 24 hours after spill occurrence. Total ambient VOC concentrations would be significant in the immediate vicinity of a large oil spill, but concentrations would be much reduced after the first day.

During open-water conditions, spreading of the spilled oil and action by winds, waves, and currents would further disperse VOC concentrations to extremely low levels 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 VOC emissions, however, would be released from the oil and dispersed, even from under the ice. In any of these situations, surface winds would further reduce VOC concentrations in the air. Concentrations of criteria pollutants would remain well within NAAQS.

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 would persist for 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 lower than for other spills.

Any accidental release of oil or gas could catch fire or could be intentionally ignited during cleanup. In situ burning is a preferred technique for cleanup and disposal of spilled oil. Burning could affect air quality in two ways. For a gas blowout, burning would reduce emissions of gaseous hydrocarbons by 99.98% and slightly increase emissions of other pollutants. If an oil spill were ignited, it would emit a plume of black smoke containing nitrogen dioxide, SO₂, CO, and PM, but the amount of VOC's that otherwise would be emitted through evaporation would be significantly reduced.

IV.C.1.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 affect air quality, but the effects would be low. Fingas et al. (1995) describes the results of a monitoring program of an oil-spill test burn at sea. The program involved extensive ambient measurements recorded during two burns in which approximately 300 bbl of crude oil were ignited. During the burn, nitrogen dioxide, SO₂, and CO emissions were measured only at background levels and frequently were below detection limits. Ambient levels of VOC's were high within about 100 m of the fire but were significantly lower than those associated with a nonburning spill. Measured concentrations of polyaromatic hydrocarbons (PAH's) were low. It appeared that a major portion of these compounds was consumed in the burn. Effects of in situ burning for spilled diesel fuel would be similar to those associated with a crude oil spill.

If the gas or oil blowout caught fire or if an oil spill was ignited intentionally to clean up and dispose of the spilled oil, burning would reduce emissions of gaseous hydrocarbons by 99.98% and very slightly increase emissions of other criteria pollutants, relative to the quantities emitted in other industrial operations (see USDOJ, MMS, 1996a:Table IV.B.12-3). If an oil spill was ignited immediately after spillage, the burn could combust 33-67% of the crude oil or higher amounts of fuel oil that otherwise would evaporate. Incomplete combustion of oil, however, would cause about 10% of the burned oil to be discharged as oily soot into the air. For a major oil blowout, in situ burning may be the only effective technique for spill control. 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% released as soot (Evans et al., 1987).

The principle contributor of pollution from a fire would be soot. Soot would cling to plants near the fire but would tend to slump and wash off vegetation in subsequent rains, limiting any health effects. Potential contamination of shoreline and onshore vegetation would be limited, however, because exploration and development and production activities under the Proposed Action would be at least 8 nautical miles (nmi) offshore, with the exception of any oil- or gas-transport pipelines.

Coating portions of the ecosystem in oily residue is not the only potential air quality risk. Smoke from burning crude oil would contain PAH's. Benzo(a)pyrene, which often is used as an indicator of the presence of carcinogenic varieties of PAH's, is present in crude-oil smoke in very small amounts, but in quantities approximately three times larger than in the unburned oil (Evans, 1988). Investigators have found that, overall, the oily residue in smoke plumes from crude oil is mutagenic, although not highly so (Sheppard and Georgiou, 1981; Evans et al., 1987). 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 ($\mu\text{g}/\text{m}^3$) beyond about 5 km 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. The Expert Committee of the World Health Organization considers daily average smoke concentrations of greater than 250 $\mu\text{g}/\text{m}^3$ to be a health hazard for bronchitis.

Summary and Conclusion for Effects of an Oil Spill on Air Quality. Over the life of oil and gas exploration, development, and production in the sale area, the likelihood of one or more large oil spills occurring is 40%. Total ambient VOC concentrations would be significant in the immediate vicinity of a large oil spill, but concentrations would be much reduced after the first day. An oil spill could be set on fire accidentally or deliberately. Burning would significantly reduce the VOC concentrations in the area, but increase slightly the concentrations of other criteria pollutants. The principle contributor of pollution from a fire would be soot. Potential contamination of the shore would be limited, however, because exploration, development, and production activities under the Proposed Action would be at least 8 nmi offshore, with the exception of any oil- or gas-transport pipelines. Smoke from an oil fire could have health risks, although the daily average smoke concentrations would be below the level that constitute health hazard for bronchitis. Other air quality effects from cleanup activities would include emissions from vessels, vehicles, and equipment used in the cleanup effort; air emissions from this equipment would be minimal. We conclude, therefore, that the effect on onshore air quality from accidental releases and corresponding cleanup efforts likely would be low.

IV.C.1.b(3) Other Effects on Air Quality. Other effects of air pollution from sale-related activities on the environment not specifically addressed by air-quality standards include the possibility for damage to vegetation from acidification of coastal areas and reduced visibility. These effects may be short term (hours, days, or weeks), long term (seasons or years), regional (Arctic Slope), or local (nearshore only).

Olson (1982) reviewed susceptibility of fruticose lichen, an important component of the coastal tundra ecosystem, to sulfurous pollutants. There is evidence that SO_2 concentration as low as $12.0 \mu\text{g}/\text{m}^3$ for short periods can depress photosynthesis in several lichen species, with damage occurring at $60 \mu\text{g}/\text{m}^3$. In addition, the sensitivity of lichen to sulfate is increased in the presence of humidity or moisture, conditions that are common in coastal areas.

For their proposed Liberty development project, British Petroleum (Exploration) Alaska (BPXA) found that maximum modeled pollutant concentrations were well below levels that can damage lichens, according to laboratory studies. Research at Prudhoe Bay from 1989 through 1994 showed no effects of pollutants there on vascular plants or lichens (Kohut et al., 1994). 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.

Visibility may be defined in terms of visual range and the contrast between plume and background, which determines perceptibility of the plume. For their proposed Liberty Project, BPXA ran the VISCREEN model, which calculates the potential impact of a plume of specified emissions for specific transport and dispersion conditions. It found noticeable effects on a limited number of days, ones that had the most restrictive meteorological conditions, but no effects at all during average meteorological conditions. We expect that those results would be representative of development projects that could occur after any discoveries following Sale 193.

A significant increase in O_3 concentrations onshore is not likely to result from exploration, development, or production scenarios associated with the proposed sale. 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 Chukchi Sea Proposed Action area most of each day during 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, O_3 measurements show that the highest 1-hour-maximum O_3 concentrations generally are in the range of 0.05-0.07 parts per million (ppm), which is well within Alaska's existing maximum 1-hour-average O_3 standard of $235 \mu\text{g}/\text{m}^3$ (0.12 ppm) and within the National 8-hour average O_3 standard of 0.08 ppm. Because the projected O_3 precursor emissions from any of the proposed sale are considerably lower than the existing emissions from the Prudhoe Bay/Kuparuk/Endicott complex, the proposed sale should not cause any O_3 concentrations to exceed the 8-hour Federal standard.

IV.C.1.b(4) Community 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 USDOJ, BLM, 1979a). Leonard Lampe, former 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 Chukchi coastal communities and the relatively small sizes of anticipated development in the Chukchi compared to the Prudhoe Bay complex, the proposed sale should have little to no significant effect on the air quality of coastal communities.

Summary and Conclusion for Other Effects on Air Quality. Because of the distance of the proposed activities from shore, attendant atmospheric dispersion, low existing levels of onshore pollutant concentrations, and compliance with Federal and State of Alaska air quality requirements, the ambient concentrations of pollutants at most locations may be assumed to be well within NAAQS. Accordingly, we conclude the effect on vegetation and visibility under the Proposed Action is low.

Air quality impacts are determined by atmospheric transport and dispersion patterns and the relative locations of the emission sources and receptors (i.e., points where impacts are felt). These characteristics will vary to some extent in different locations within the Chukchi 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 also are very complex.

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, let alone the Chukchi Sea. The air quality modeling for these projects are based on the best available information for the Beaufort Sea. Results for a similar project in the Chukchi Sea likely would vary, depending on local meteorological and topographical conditions. However, because the predicted air quality impacts from these facilities are small, it can be reasonably assumed that the effects from oil and gas facilities anywhere in the region would fall within the regulatory standards. Data from the Prudhoe Bay/Kuparuk/Endicott oil-production complex supports this conclusion.

Because individual air masses move constantly with atmospheric circulation, we expect that the major differences in effects of the different alternatives on 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 sale would result in significant effects different from or other than those discussed in Section IV.C.1.b(1). Air quality effects of all activities under all sale alternatives would cause only small increases in the concentrations of criteria pollutants. Concentrations would be within the PSD Class II limits and NAAQS. Therefore, effects from each alternative would be low. IV.C.1.b(5) Effects of The Proposed Action.

The Proposed Action would have the highest potential for impacts to shore, because it has the largest area available for leasing. Potentially affected areas primarily would be locations on the Chukchi coast of Alaska.

IV.C.1.c. Lower Trophic-level Organisms.

IV.C.1.c(1) Conclusion. The disturbance effect of 14 anticipated exploratory wells probably would be low, unless the wells were located near any special biological communities; regardless, MMS would review further any installation proposals and could require surveys. Exploratory discharges during summer probably would lead to low effects at deep offshore locations and to slightly greater local effects in the shallower nearshore portions of Alternative I. Water circulation under the winter ice cover is relatively slow, so we assume that produced water would be reinjected; regardless, the local effects of produced-water discharge for the life of the field probably would be moderate (Sec. IV.C.1.c(4)(a)2), but any such discharge proposals would be reviewed in detail by MMS and USEPA. We assume that an extensive system of buried pipelines would radiate from a central production platform, and that a single pipeline would extend to shore. This pipeline installation probably would disturb 1,000-2,000 acres of typical benthic organisms that would slowly recolonize the area within a decade, leading overall to a major level of effect. The disturbance effects would be assessed and probably monitored by the pipeline company, MMS, and/or the Corps of Engineers. The effects of an alternative to production pipelines—the transportation of

produced oil in vessels—would pose a much greater spill risk to the coast near the spring lead system. The Oil-Spill-Risk Analysis (OSRA) model estimates a 40% chance of one or more large spills $\geq 1,000$ bbl occurring over the production life of Alternative I, but only 1% chance of one or more large spills occurring and contacting the U.S. Chukchi coastline within 3 days over the production life of Alternative I. If a large oil spill did contact this coastline, the oil probably would persist in a few of the tidal and subtidal sediments for a couple of decades, leading to a local but moderate effect on the few intertidal lower trophic-level organisms. The chance of one or more large spills contacting the U.S. Chukchi coastline increases to 6% within 30 days over the production life of Alternative I, demonstrating the advantages of requirements for rapid response capability. During the abandonment phase, we assume that the extensive pipeline system would be cleaned, plugged, and abandoned in place, at which time it would become a public responsibility; bond requirements could be increased for Chukchi developers, making the bond size commensurate with the estimated financial obligations associated with the careful construction and abandonment of pipelines. Overall, the effect on lower trophic-level organisms with standard mitigation would be local but moderate, and the level with proposed requirements for rapid spill-response capability and for larger development bonds would be minor.

IV.C.1.c(2) Effects from 3D/2D Seismic Surveys. The Chukchi Sea Sale 126 EIS concluded that seismic surveys would have very low effects on lower trophic-level organisms (USDOJ, MMS, 1990a:Sec. IV.C.3.a). The conclusion is consistent with the results of a recent, detailed review by the Canadian government on the impacts of seismic sound on invertebrates and other organisms (Canadian Department of Fisheries and Oceans [CDFO], 2004d). The CDFO review concluded that there are no documented cases of invertebrate mortality (i.e., of adult lifestages, as opposed to eggs or larval lifestages) on exposure to seismic sound under field-operating conditions. Similarly, the MMS seismic-survey Programmatic Environmental Assessment (PEA) (USDOJ, MMS, 2006a) and the National Marine Fisheries Service's (NMFS) Biological Opinion for proposed Beaufort Sea 202, dated June 2006 (USDOJ, MMS, 2006e), conclude that invertebrates probably would not be affected, with the possible exception of squid. In summary, the effect of seismic exploration on benthic and planktonic organisms probably would be immeasurable. Regardless, the effects of specific seismic exploration under standard stipulations (<http://www.mms.gov/alaska/re/permits/stips1-5.htm>) will be assessed later by MMS.

The following assessment is separated into the effects of exploration phase and then the effects of the development and abandonment phases. The assessments examine the possible effects of the proposed lease sale in the context of several broad-scale climate changes, as summarized in Section III.B.1. An important aspect for this assessment of effects on lower trophic-level organisms is that the ecosystem is changing, but the changes apparently are not due to previous oil exploration, although they may be related to climate change and the burning of fossil fuels.

IV.C.1.c(3) Effects from Exploration. The assessment of the exploration phase is separated into the effects of routine (permitted) exploratory operations and those from accidental spills.

IV.C.1.c(3)(a) Routine Activities. Routine (permitted) operations would include disturbances, discharges, and small spills.

IV.C.1.c(3)(a)1 Disturbances. Disturbances would be due to shallow-hazard surveys and possible anchoring of drilling vessels. The Chukchi Sea Sale 126 EIS concluded that disturbance would have very low effects on lower trophic-level organisms (USDOJ, MMS, 1990a:Sec. IV.C.3.b).

Specifically, shallow-hazard studies often include sampling of the seafloor with sediment grabs and/or cores. The effect of such sampling would be substantial only in special biological communities (Sec. III.B.1.b). Kelp communities occur only in relatively shallow water, inshore of the proposed lease area (USDOJ, MMS, 1990a:Sec. III.B.1.c (1)). With this exception, the effects of seafloor surveys would be very small; regardless, the effects of specific proposals could be reviewed further by MMS.

Disturbance might be caused also by the anchoring of drillships and/or drilling vessels, and the construction of "well cellars" for seafloor well-head equipment. Drilling vessels might include the *Kullu*, which a petroleum company has proposed to use for exploration of Beaufort Sea prospects (USDOJ, MMS, 2007). The *Kullu*, previously named the *Kulluk* and used to explore the Belcher prospect in about 160 feet (ft) of water, is anchored on location, usually with about eight large anchors. The seafloor disturbance during

previous drilling at the Belcher and five Chukchi Sea prospects apparently was very low—possibly like the seafloor disturbance caused by the deep ice keels that ground almost yearly on the relatively shallow Hanna Shoal near the center of the proposed lease area (Eicken et al., 2006; Appendix A.1, Map A-2a, ERA 48; Sec. II.A.1). Therefore, the disturbance effect of seafloor sampling and 14 anticipated exploratory wells probably would be low, unless they were located near any special biological communities, and MMS could require operators to conduct benthic surveys for such communities.

IV.C.1.c(3)(a)2 Discharges. Exploratory discharges would include an estimated 3,000 short tons of drilling mud per year and, over the 7-year period of exploratory drilling, an estimated total of about 26,000 short tons of drilling mud and 33,000 short tons of drill cuttings. Detailed information on any proposed discharges from Sale 193 leases would be contained in future EPs, including the general toxicity of the discharges; and that information would be reviewed by MMS and USEPA. The volumes that might be released from Sale 193 leases are similar to the estimated discharge volumes in the Chukchi Sea Sale 126 EIS. The 126 EIS concluded that the effect on benthic organisms would be low, and the effects on pelagic organisms would be very low (USDOJ, MMS, 1990a:Sec. IV.C.3.c). Muds and cuttings were discharged during the previous exploratory drilling of five wells in about 140 ft (40 m) of water in the Chukchi Sea. The description of the environment (Sec. III.B.1) identified no offshore areas of high production, or biological “hot spots,” that might be affected by discharges. The proposed Sale 193 area includes some nearshore tracts that were not included in Chukchi Sea Sale 126. The water depth of the inner tracts is about 100 ft (30 m). Discharges in the adjacent Beaufort Sea are restricted in shallower water (<30 inches [10 m]), because the water circulation is very restricted under the landfast ice cover during the long winter. The water circulation across the Chukchi shelf is not restricted during the exploratory drilling season (i.e., during the summer, open-water period), as shown by the estimated monthly exchange of about half the water on the shelf near the old Burger drill site (Woodgate, Aagaard, and Weingartner, 2005). However, in the coastal waters, the circulation might not be as rapid and the productivity is generally higher, as explained in Section III.B.1. Furthermore, the coastal benthic communities are fed on by many marine mammals and birds that use the coastal areas as a migratory corridor, as discussed in Sections III.B.5 and IV.C.f and g. Drilling muds are composed primarily of bentonite (clay), so the toxicity is low. The drilling muds probably would not kill benthic organisms, but any heavy metals in them might be accumulated by benthic organisms, adding to the body burden in vertebrate consumers. Inorganic mercury accumulated in the sediment near an old platform in the Gulf of Mexico, but the platform did not have the new USEPA limits on mercury discharges. In northwest Alaska, the atmosphere is a source of mercury contamination (Garbarino et al., 2002). Total and methyl mercury in zooplankton from the outer Chukchi Sea is relatively low; but apparently it can be accumulated by zooplankton, as shown by those organisms from the Canadian portion of the Beaufort Sea (Stern and Macdonald, 2005). Overall, the exploratory discharges during summer probably would lead to low effects if they were offshore but to slightly greater local effects in relatively shallow water nearer to the coast; regardless, discharge proposals would be reviewed by MMS and the USEPA.

IV.C.1.c(3)(a)3 Small Oil Spills (less than 1,000 barrels). A small spill might occur during operations when, for example, fuel oil is being transferred from a barge to a drilling vessel in offshore water. The assumed size is several hundred barrels (see Table IV.A-4). The volume would be relatively small, because the pumps and/or hoses could be controlled and shut off. Because of relatively small size of operational spills, and the offshore location of them, the effects probably would be very low. The seismic-survey PEA concluded similarly (USDOJ, MMS, 2006a:Sec. III.D.1.f). (This assessment does not cover the effects of an exploratory blowout; those effects would be similar to the effects of a large production spill, as discussed in Section 4(b) below.)

IV.C.1.c(3)(a)4 Summary of Exploration Effects. The effect of seismic exploration and small operational spills on lower trophic-level organisms probably would be immeasurable to very low. The disturbance effect of the anticipated 14 additional exploratory wells in the proposed lease probably would be low except near any special biological communities. The MMS and USEPA would review any discharge proposals, but the probable effect of discharges on pelagic organisms would be very low and on deep benthic communities would be low, and discharges in relatively shallow areas near the coast would probably lead to moderate effects.

IV.C.1.c(4) Effects from Development Projects. The following section assesses the effects of routine (permitted) development activities, accidental large oil spills, and eventual abandonment.

IV.C.1.c(4)(a) Routine Activities. The effects of routine activities would include disturbances (construction) and discharges. Seismic surveys would not affect lower trophic-level organisms, as explained above.

IV.C.1.c(4)(a)1 Disturbances (Construction). Disturbance would be caused partly by the installation of production platforms. We estimate that there might be one such platform and, like the bottom-founded Single Steel Drilling Caisson, it would have a footprint of several acres. The impact of the disturbance of several acres of benthos in the whole Chukchi Sea probably would be very minor. Regardless, MMS would review in detail any DPPs, including any plans for platform installation; and could require seafloor surveys before the installation of any platforms. The Corps also would review the proposals for platform installation, if they involved “fill” or construction of a berm.

A much larger area would be disturbed during the burial of offshore pipelines. We estimate that numerous subsea pipelines would radiate out from each production platform, gathering the production from 20-30 subsea templates with 80-120 wells total. Also, a single pipeline would be buried from a production platform to shore over an estimated distance of 30-150 mi. We estimate that, overall, 120-250 mi of production pipelines might be laid on the Chukchi seafloor. Ice has gouged the seafloor in water up to about 50 m in depth, so almost all of the pipelines would have to be buried deep enough to avoid disturbance from ice keels. The subsea soil in the Chukchi Sea is mostly unconsolidated, as explained in Section III.B.1.b. Twelve-foot deep pipeline trenches in unconsolidated Beaufort Sea soil would have been up to 130 ft wide at the top, as estimated for a development pipeline to the Liberty Prospect (USDOI, MMS, 2002:Sec. III.C.3.e(2)(b)2)b)). If we assume that Chukchi pipeline trenches would be about half that width (70 ft), about 1,000-2,000 acres of Chukchi seafloor might be disturbed during the burial of production pipelines. The seafloor is inhabited by mollusks (clams) and other infauna that are particularly abundant in the northern and northeastern parts of the proposed lease area (Feder et al., 1994:Fig. 4b). As explained in Section III.B.1.b, the recolonization time of disturbed benthic areas is slow, and that specifically only about 65% of the benthic organisms recolonized a disturbed area within 9 years (Conlan and Kvitek, 2005). The large clams on which walrus usually feed (Sec. IV.C.1.h(3)) are probably some of the last organisms to recolonize disturbed areas. Therefore, this assessment assumes that the recovery time would require slightly more than a decade. Overall, we assume an extensive system of buried pipelines that would disturb 1,000-2,000 acres of typical benthic organisms that would slowly recolonize the area within a decade, leading overall to a major level of effect. We note that the previous assessment of pipelines in the Chukchi Sea (USDOI, MMS, 1990a:Sec. IV.C.3.d), which concluded that the effect would be low, assumed less-extensive gathering fields and did not estimate the duration of the disturbance effects.

Standard mitigation that might help to reduce the moderate level of effects is Stipulation No. 1, Protection of Biological Resources. In the Beaufort Sea, that stipulation has helped to moderate the level of effects on special biological communities, such as the kelp community in the Stefansson Sound Boulder Patch. Kelp communities in the Chukchi Sea occur only nearshore, but they might be disturbed by a production pipeline. The stipulation would help to detect kelp and other special biological communities and to reduce the levels of effects on them.

Although the disturbance effects would be serious, an alternate to buried production pipelines—the effects of transporting production by vessel—would be more serious. This is partly because barges or vessels carrying relatively large amounts of oil might be routed to a facility on the coast or through the Bering Strait. The consequences of a tanker or barge spill on the Chukchi coastline might be similar to the effects of a low-probability, very large oil spill (USDOI, MMS, 2003a:Sec. IV.I) and much worse than the disturbance due to pipeline burial. The relative low risk of transporting oil through pipelines is part of the reason for the standard MMS Stipulation No. 3, Transportation of Hydrocarbons (Sec. II.B.2.c). That stipulation requires the use of pipelines, if they are economically feasible, to transport OCS production to shore. Historical records for Gulf of Mexico OCS production show that a smaller percentage of production is spilled from pipelines than by alternate transportation methods, such as the barges that were sometimes used to transport nearshore oil to shore. Barges and or tankers are still used in some situations. For example, a prospect near Sakhalin Island, Russia, was developed recently, using tankers to transport oil from an offshore terminal that is covered seasonally by sea ice. Tankering of Chukchi Sea OCS production would mean the transport of oil across the area of the spring lead system or through the Bering Strait, both of which are extremely important for marine mammal and seabird migrations along the Chukchi Spring Lead System (SLS).

The future MMS and the Corps' review of proposals for offshore platforms and pipelines would make sure that the facilities avoid special biological communities, but the anticipated pipeline system probably would affect 1,000-2,000 acres of typical benthos, leading to a moderate effect. The chance of spill occurrence of one alternative to production pipelines—the transportation of produced oil by vessel—probably would be much greater.

IV.C.1.c(4)(a)2) Discharges. The effects of production discharges of drilling muds and cuttings would be similar to the effects of exploratory discharges (Sec.(3)(a)2), above). That section concluded that the effect on pelagic organisms would be very low and on deep benthic communities would be low, but discharges in relatively shallow areas near the coast probably would lead to moderate effects. A difference in discharges during the production phase is that water usually is produced with oil and gas, resulting in the necessary disposal of treated produced water. Produced water typically contains polycyclic aromatic hydrocarbons (PAH), so is toxic to organisms, and would be produced all year during production. Also, the volume of produced water is estimated at 2.4-43 Bbbl for the proposed sale (Sec. IV.D.1.a(9)(b)), but the volume would be greatest during late production; e.g., water is now about half of the fluid that comes from old Prudhoe Bay wells. The fate of produced water has been studied in the North Sea where it is discharged from some platforms (Durell et al., 2006). The water depth (30-40 m) is similar to the Chukchi Sea depths, and the circulation is similar to that in the Chukchi during the summer open-water season. Durell et al. found that the PAH concentration was above the background concentration within 5-10 km of the discharge locations—areas within which they estimated a 100,000-fold dilution of PAH. An implication for the Chukchi Sea is that PAH concentrations might be measurable within several kilometers of any platform during summer. However, during the winter ice-covered season the water circulation is much slower, so dilution would occur relatively slowly. For example, the exchange period for half of the water on the Chukchi shelf is about one month during summer but extends to about six months during winter (Woodgate, Aagaard, and Weingartner, 2005). Any discharge of produced water in the Chukchi during the winter probably would lead to PAH concentrations above background concentrations at the farther end of the range from Durell et al. (2006)—i.e., within 10 km of the discharge locations. An NPDES permit application to the USEPA would initiate a review of any proposed discharges. The NPDES program requires that water quality-based limitations be applied, as prescribed in the Clean Water Act at 403(e), to ensure that no unreasonable degradation occurs. The evaluation would examine also non-water quality impacts (e.g., air emissions, potential for spills, etc.) associated with different options. Further, if produced water is discharged, the toxicity of the discharge would be carefully monitored and regulated under the EPA NPDES program.

IV.C.1.c(4)(a)3) Small Production Spill. The effect of small oil spills was assessed in Section IV.C.1.c(3)(a)3). It concluded that, because of the relatively small size of operational spills, and the offshore location of them, the effects would be immeasurable. The effect of small production spills would be similar.

IV.C.1.c(4)(b) Large Oil Spill (greater than or equal to 1,000 barrels). The Chukchi Sea Sale 126 EIS concluded that the effects of a large oil spill on marine plants and invertebrates would be very low, and the effect on nearshore communities would be low (USDOJ, MMS, 1990a:Sec.IV.C.3.a). The assessment did not include some of the nearshore tracts that are included in the Proposed Action for proposed Sale 193 (but that are excluded from Alternatives III and IV). In the current assessment, we update the effect of a large spill ($\geq 1,000$ bbl), for which there is a 40% chance of one or more large spills occurring over the production life of Alternative I (Sec. IV.A.4.a). A 4,600-bbl spill is estimated to cover 51 km² of water within 3 days and 1,008 km² within 30 days during summer. The spilled oil would float, affecting the neuston (open-water surface zooplankton) and/or the underice biota (Gradinger and Bluhm, 2005), but not the benthos. As discussed elsewhere in this assessment, the spill might persist on the water surface for a month (Appendix A.1, Sec. 2). A planktonic habitat that is special (i.e., is a biological “hot spot”) occurs in the southwestern Chukchi Sea near the Bering Strait and along the Russian Chuktoka coast during August (Sec. III.B.1.a). The area corresponds to environmental resource areas (ERA's) 3 and 4 (Appendix A.1, Map A-2a). The OSRA model estimates up to a 7% chance of a large spill from any launch area within the proposed lease sale area contacting ERA 3 or 4 within 30 days during summer (Appendix A.1, Table A.2-27). The OSRA model estimates the chance of a spill contacting Russian water (and plankton in the water) just to the west of the proposed lease area is 9% or less within 10 days for launch areas near the border (Appendix A.1, Sec. C.4.a(1)(a) and Appendix A.2 Table A.2-91). The persistence of any effect on the planktonic populations probably would last a month, judging by the water-exchange rate on the Chukchi

shelf, as discussed by Woodgate, Aagaard, and Weingartner (2005) and in Section IV.C.1.c(3)(a)2 about discharges. Given the chance of contacting Russian organisms and the persistence of the effects, the MMS could possibly require an extra spill response provision, such as an agreement with Russia about emergency responses, as part of the regular MMS review of Oil Spill Response Plans (OSRP's) for any western Chukchi development plan (Sec. IV.A.5).

If such a spill drifted to the coast, the effects would persist much longer. A 1,500-bbl spill of crude oil probably would contaminate 25 km of tidal and subtidal sediments (Appendix A.1, Table A.1-5a) and, despite cleanup responses, it probably would persist for many years in some shoreline sediment. Most of the U.S. Chukchi coast is exposed to storm waves, so the coast is gradually eroding. The coast is composed primarily of tundra cliffs and gravel beaches but includes a few marshes and tidal flats (Research Planning, Inc., 2003; Appendix A.1, Table A.1-4). Even in the marshes, there would not be well developed communities because of the winter ice. The persistence of oil in arctic marshes and tidal flats is discussed in the Beaufort Sea multiple-sale EIS; it concludes that oil would persist on such shorelines for more than a decade (USDOI, MMS, 2003a:Sec. IV.C.2.a(3)(b)1)). Oil has persisted in the tidal and subtidal sediments of Prince William Sound for about one and a half decades (USDOI, MMS, 2004:Sec. IV.C.1.e(3) and in the marsh sediments of New England for about three and half decades (Peacock et al., 2005).

The chance of one or more large spills occurring and contacting the U.S. Chukchi shoreline is low but increases rapidly with the duration of the trajectories. The OSRA model estimates the chance of one or more spills $\geq 1,000$ bbl occurring and contacting the U.S. Chukchi coast over the production life of the Proposed Action. This coastline is adjacent to the SLS. The OSRA model estimates a 1 and a 6% chance of one or more spills $\geq 1,000$ bbl occurring and contacting the U.S. Chukchi Coast within 3 and 30 days respectively, over the production life of the proposed action for Alternative I (Appendix A.1, Tables A.2-85 and -87).

The MMS regulations and a standard stipulation would help to prevent spills, and to moderate the effects of any that occur. The MMS regulations require operators to prepare an OSRP as part of their EP (30 CFR 250.42); the OSRP is reviewed by MMS at the same time that the EP is reviewed. Some previous OSRP's that were approved for operations in the Chukchi Sea included the voluntary storage of response equipment on site (i.e., on a barge) to speed responses. The Federal Oil Pollution Act of 1990 and MMS Stipulation No. 6, Oil-Spill-Response Preparedness, also would help to reduce spill effects. The Act and stipulation would require operators to conduct drills to demonstrate readiness. The regulations and stipulation are important to lower trophic-level organisms, because the main effects on the organisms would be spill related. As explained above, if a spill contacted the coastline, oil would persist in the intertidal and subtidal. This assessment explains that there is a very low chance that a spill would contact the U.S. Chukchi coast within 3 days; but that the chance rises 20% for a 10-day trajectory and another 400% for a 30-day trajectory. The difference demonstrates one advantage of local response equipment at drill sites in the Chukchi Sea.

IV.C.1.c(4)(c) Eventual Abandonment. The abandonment phase is far in the future, after the estimated 30- to 40-year life of an oil field, and after the possibly installation of gas line and production of gas. However, when any field is no longer economic, the operator would request MMS and the Corps approval of an abandonment plan, as required by 30 CFR 250.1750 (Sec. IV.A.2.f). The pipelines could be cleaned, plugged, and abandoned in place. The MMS approval of such an abandonment plan means that the buried pipelines would become public property—and a public responsibility. For that reason, any pipeline-construction proposals would be reviewed very carefully by the MMS and probably the Corps. These agencies would make sure that the pipelines would be buried deeply enough to remain buried as long as the pipeline would maintain integrity, withstanding even the ice keels that might occur only once every few hundred years after abandonment.

IV.C.1.c(4)(d) Summary. During the exploration phase, the effect of seismic activity and small operational spills on lower trophic-level organisms probably would be immeasurable to very low. The disturbance effect of the anticipated 14 additional exploratory wells in the proposed lease probably would be low except near any special biological communities. The USEPA might review any discharge proposals, but the probable effect of discharges on pelagic organisms would be very low and on deep benthic communities would be low, and discharges in relatively shallow areas near the coast probably would lead to moderate effects.

During the production phase, the MMS and USEPA would review any development discharge proposals, but the probable effect of discharges on pelagic organisms would be very low and on deep benthic communities would be low, and long-term discharges in relatively shallow areas near the coast probably would lead to moderate effects. Future MMS and the Corps reviews of proposals for offshore platforms and pipelines would make sure that the facilities avoid special biological communities, but the anticipated pipeline system would probably affect 1,000-2,000 acres of typical benthos, leading to a moderate effect. The risk of an alternative to production pipelines—transportation of produced oil by vessel—would be much greater. The effect would be very low for a large spill at an offshore location, as concluded also in the Chukchi Sea Sale 126 EIS. Proposed Sale 193 includes some nearshore tracts that were not included in previous sales. If a spill from these tracts contacted the coast, the oil probably would persist in a few tidal and subtidal sediments for a decade, leading to a moderate impact. Quick response to nearshore spills with onsite response equipment would reduce the level of effect from moderate to minor.

During the abandonment phase, we assume that buried pipelines would be cleaned, plugged, and abandoned in place. If companies carry out such abandonment plans as approved, the pipelines would become a public responsibility.

IV.C.1.c(5) Effectiveness of Proposed Mitigation Measures. As explained above, Stipulation No. 3, Transportation of Hydrocarbons, would require pipelines if they are economically feasible in comparison with barging or tankering production to shore. In other words, Stipulation No. 3 does not contain an absolute requirement for pipelines. Also, MMS has regulations for the cleaning and abandonment of pipelines in place; the careful abandonment of pipelines is important because they would be there forever. An additional way to encourage the careful construction and abandonment of pipelines in the Chukchi Sea would be to increase the size and longevity of the bond requirements for any development. Three million dollars is the standard bond requirement for developments in an OCS lease area like the Chukchi Sea. A larger bond would help the Government to obtain reimbursement for any additional liability by the owner/operator of an extensive pipeline system. Also, a long-term bond would help with responses to unexpected problems after abandonment, such as the contamination caused by two abandoned pipelines in State water in upper Cook Inlet (Epstein, 2002:Appendix 2; Cook Inlet Regional Citizens Advisory Council, 2001; ADEC, 1998).

As explained above, there is a 1% chance of one or more large spills occurring and contacting the U.S. Chukchi coast within 3 days (72-hours), but MMS regulations and Stipulation No. 6 would help to reduce the level of spill effects. The relative chance of contact within 30 days is an indication of the benefit of rapid responses. The chance of contact with the coastline rises to 6% for 30-day trajectories. Rapid response to spills in the Chukchi Sea would lower substantially the chance of contact with land. Previous operations in the Chukchi Sea that were approved by MMS included the voluntary storage of response equipment on site (i.e., on a barge). The MMS could require such local response equipment during the review and approval of OSRP's (Sec. IV.A.5). The State of Alaska has such regulations, requiring responses within 72 hours. With a lease-sale requirement for local response equipment or a 72-hour response threshold, the level of effect on lower trophic-level organisms along the coast would decrease from moderate to minor.

IV.C.1.d. Fish Resources.

A lease sale in the Chukchi Sea would initiate a process that begins with seismic surveys. Exploration of promising geologic formations may lead to an exploration phase that may include additional seismic work and drilling of exploratory wells to better describe or delineate an oil-bearing formation. Full development of an oil resource would include drilling of production wells and construction of a platform to collect oil from production wells and pump it via pipeline to a support base onshore, where it would be transported further to the existing infrastructure to markets. The potential impacts from these activities are evaluated by two categories: effects from 3D/2D seismic surveys and effects from exploration and development.

IV.C.1.d(1) Summary.

IV.C.1.d(1)(a) Seismic Surveys. Because of the paucity of studies in the Chukchi Sea, a review of the available science and management literature shows that at present, there are no empirical data to document potential impacts from seismic surveys reaching a local population-level effect; also, the experiments

conducted to date have not contained adequate controls in place to allow us to predict the nature of a change or that any change would occur. Thus, the information that does exist has not demonstrated that seismic surveys alone would result in significant impacts to marine fish or related issues (e.g., impacts to migration and spawning, rare species, subsistence fishing).

IV.C.1.d(1)(b) Exploration and Development. Noise, habitat changes, and discharges from drilling operations, dredging, pipeline trenching, gravel mining, and abandonment can have a measurable effect on fish populations. The nature of these impacts primarily are short- and long-term displacement from work areas due to emitted underwater sounds and sediment plumes, short-term losses of seafloor habitats and individual organisms during platform and pipeline construction (excavation/smothering), and multiyear injury/mortality in a “zone-of-influence” (as measured by radii thousands of meters long) from piles of discharged well-drilling fluids around exploratory well drilling sites. While some fish could be harmed or killed, most in the immediate area would avoid these activities and otherwise would be unaffected.

In the event of a large crude or diesel-fuel spill, effects on arctic fishes (including anadromous species) primarily would depend 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 low numbers in the spill area, no immediate effects are likely on fishes during winter. Effects more likely would occur from an offshore oil spill during summer or spring melt out, moving into nearshore waters, where fishes concentrate to feed, migrate, and spawn or rear. If an offshore spill did occur and contact the nearshore area, some marine and migratory fish likely would be harmed or killed. For some of the more abundant fish species (e.g., capelin, herring), spawning aggregations in some coastal reaches could be lost but could be replaced within less than three generations from the larger population. As juvenile salmon often rear offshore of spawning streams, entire zero-year cohorts of some local streams could be lost and recovery would occur only by recolonization by strays from unaffected populations. Recolonization to prespill population size would take more than three typical generations to occur.

Given a lack of contemporary abundance and distribution information, effects on rare or unique species (including potential extirpation) could occur, but it would likely go unnoticed or undetected.

Chronic small-volume crude and refined spills from all operations associated with production (25/year) typically would be 29-126 gal (0.7-3 bbl) in size. Depending on the launch area, spills of this size could dissipate before reaching important fish habitats; however, the large number of spills may result in spills reaching coastal areas, i.e., one spill per 2 years. The small-volume spill rate included spills from a future pipeline on land, and these spills could reach freshwater habitats used by fish.

In the event of an onshore pipeline oil spill contacting a small waterbody supporting fish and having restricted water exchange, it likely would kill or harm most or all of the fish within the waterbody. If all of the fish in an isolated waterbody were killed, natural recovery would not occur. If habitats were restored and there was open exchange to other populated waterbodies, recovery would be likely in 5-10 years.

IV.C.1.d(2) Potential Effects from 3D Seismic Surveys. The following information is largely an abridged version of a more detailed description of the potential effects of seismic surveys evaluated for the seismic-survey PEA (USDOI, MMS 2006a).

The principle impacting agent attributable to the 3D seismic surveys involves the acoustic-energy pulses emitted by airguns. Additional impacting agents involve vessel-traffic noise and anchoring and the introduction of hydrophone arrays towed or suspended in the ocean or placed on the seafloor. This section evaluates the acoustic impacts associated with airgun emissions and vessel noise and mechanical impacts to habitat (i.e., via anchoring, cable towing, deployment and retrieval from the seafloor, and cable hangups).

IV.C.1.d(2)(a) Acoustic Detection and other Sensory Capabilities. Marine organisms have evolved a plethora of ways to sense their environment and use these senses to provide information that allows them to communicate and to find their way (Popper, 2003). Fish can detect sounds via the sacculus of the ear (one of the inner ear end organs) (Popper et al., 2003). Studies have demonstrated that many fish species produce and use sounds for a variety of behaviors, with some discriminating between different frequencies and intensities, and detect the presence of a sound within substantial background noise (Popper et al., 2003). Fish use sounds in behaviors including aggression, defense, territorial advertisement, courtship, and

mating (Popper et al., 2003). Hearing in fish is not only for acoustic communication and detection of sound-emitting predators and prey but it also can play a major role in telling fish about the acoustic scene at distances well beyond the range of vision (Popper et al., 2003).

Some teleost species can detect infrasound (sounds below 20 Hertz [Hz]). Juvenile salmonids display strong avoidance reactions to infrasound (Popper et al., 2003, citing Knudsen et al., 1992, 1997), and it is reasonable to suggest that such behavior has evolved as a protection against predators. Infrasound has been used as an effective acoustic barrier for downstream migrating Atlantic salmon (*Salmo salar*) smolts (Popper et al., 2003, citing Knudsen et al., 1994).

There probably is no other sensory system as specialized for sensory processing in the aquatic environment as the lateral-line system (Coombs and Braun, 2003). It is a water-current detector found exclusively in aquatic fish and some amphibians. The lateral-line system is generally a close-range system, capable of detecting current-generating sources (e.g., nearby swimming fishes) no more than one or two body lengths away. The lateral-line system also can detect ambient water motions, such as those in a stream or ocean current, as well as distortions in ambient or self-generated motions due to the presence of stationary objects, such as rocks or boulders. As such, the lateral-line system is believed to influence a number of different behaviors, including schooling, prey capture, courtship and spawning, and rheotaxis. In a more general sense, the lateral-line system undoubtedly also is used to form hydrodynamic images of the environment, enabling fishes to determine the size, shape, identity, and location of both animate and inanimate entities in their immediate vicinity.

Evidence suggests that the lateral line serves as a pressure gradient and particle-motion sensor enabling schooling fish to mediate their proximity and velocity within the body of their school (Stocker, 2002, citing Cahn, 1970, Partridge and Pitcher, 1980). Stocker (2002) suggests that a school of fish could be modeled as a low-frequency oscillating body that the individual fish synchronize to. This view is supported by the visual presentation of fish schools in sunlight that sometimes appear to “flash” simultaneously as they respond to disturbances. This is substantiated also by evidence that when startled by airgun noise, schooling fish fall out of rank and take time to reassemble (Stocker, 2002, citing McCauley et al., 2000). The startle response involves establishing a tighter grouping, so the observed response is not believed a scatter response. The interruption or startle response observed in the airgun study might indicate that the hearing of individual fishes is momentarily compromised, or the pressure-gradient field of the school is disturbed sufficiently to lose its integrity and then takes time to reestablish, or perhaps some combination of both.

Squid have demonstrated responses to sound (Stocker, 2002). This may have something to do with their schooling nature that requires synchronization with the school, and predator-aversion perception akin to that of schooling fishes (Stocker, 2002).

While researchers noticed a predictable startle response from squid at 174 decibels (dB) (i.e., firing of ink sacks and avoidance behavior) from instantaneous impact noise, a ramped noise indicated a response threshold of 156 dB in a noticeable increase in alarm behavior-increase in swimming speed, and presumably shifts in metabolic rates (Stocker, 2002, citing McCauley et al., 2000). Squid response to ramped noise also includes their rising toward the surface where an acoustical shadow of 12 dB was observed. This indicates an annoyance sensitivity of perhaps 144 dB (Stocker, 2002).

IV.C.1.d(2)(b) Potential Impacts from Airgun Acoustic Emissions. Fishes of greatest concern, due to their distribution, abundance, trophic relationships, or vulnerability, are: (1) the diadromous fishes that are abundant seasonally in the nearshore zone, especially arctic char, least cisco, and broad whitefish; (2) cryopelagic fishes such as the arctic cod, an abundant and trophically important fish; (3) intertidal/estuarine/nearshore spawning and/or rearing fishes (e.g., capelin and Pacific herring); and (4) Pacific salmon. Some of these species also are important because they figure prominently in subsistence (e.g., arctic char, ciscoes, whitefishes, arctic cod, rainbow smelt, capelin, and salmon).

In general, marine fish likely can hear airgun sounds with seismic airgun emissions, especially for hearing generalists (e.g., flatfishes) and specialists (e.g., herring). The frequency spectra of seismic-survey devices cover the range of frequencies detected by most fish (Pearson, Skalski, and Malme, 1992; Platt and Popper, 1981; Hawkins, 1981). Marine fishes are likely to detect airgun emissions nearly 2.7-63 km (1.6-39 mi)

from their source, depending on water depth (Pearson, Skalski, and Malme, 1992). Fish responses to seismic sources are species specific (Pearson, Skalski, and Malme, 1992).

IV.C.1.d(2)(b)1 Mortality and Physiological Damage. Seismic-survey acoustic-energy sources may damage or kill eggs, larvae, and fry of some fishes occurring in close proximity to an airgun, but the harm generally is limited to within 5 m (15 ft) from the airgun and greatest within 1 m (3 ft) of the airgun (e.g., Kostyuchenko, 1973; Dalen and Knutsen, 1987; Holliday et al., 1986; Turnpenny and Nedwell, 1994). Airguns are unlikely to cause immediate deaths of adult and juvenile marine fishes. Sound sources that have resulted in documented physiological damage and mortality of adult, juvenile, and larval fish all have been at or above 180 dB re 1 microPascal (180 dB re 1 μ Pa) (Turnpenny and Nedwell, 1994). The likelihood of physical damage is related to the characteristics of the sound wave, the species involved, life stage, distance from the airgun array, configuration of array, and the environmental conditions.

The CDFO (2004c) reviewed scientific information on impacts of seismic sound on fish and concluded that exposure to seismic sound is considered unlikely to result in direct fish or invertebrate mortality. Damage to fish from seismic emissions may develop slowly after exposure (Hastings et al., 1996). Table 1 of Turnpenny and Nedwell (1994) lists observed injuries (for fishes: adult, juvenile, larvae, and eggs) caused by exposure to high-level sound sources.

Overall, the available scientific and management literature suggests that mortality of juvenile and adult fish, the age-classes most relevant to future reproductive fitness and growth, likely would not result from seismic-survey activity. Fishes with impaired hearing may have reduced fitness, potentially making them vulnerable to predators, possibly unable to locate prey or mates, sense their acoustic environment or, in the case of vocal fishes, unable to communicate with other fishes. Given that this most likely would occur to fish within very close proximity to the sound source, MMS anticipates any injury to adult and juvenile fish to be limited to a small number of animals. A mitigation measure requiring the ramp up of the airgun emissions (Sec. II.B.4) would provide fish with an opportunity to move away from the source and is expected to reduce the risk of injury or altered behavior to negligible levels.

IV.C.1.d(2)(b)2 Impacts to Behavior. The most likely impacts to marine fish and invertebrates from seismic activity would be behavioral disruptions. Behavioral changes to marine fish and invertebrates from seismic-survey activity have been noted in several studies (e.g., Dalen and Knutsen, 1987; McCauley et al., 2000; McCauley, Fewtrell, and Popper, 2003; Pearson, Skalski, and Malme, 1992), including: balance problems (but recovery within minutes); disoriented swimming behavior; increased swimming speed; tightening schools; displacement; interruption of important biological behaviors (e.g., feeding, mating); shifts in the vertical distribution (either up or down); and occurrence of alarm and startle responses (generally around 180 dB re 1 μ Pa and above). Behavioral impacts are most likely to occur in the 160- to 200-dB range (Turnpenny and Nedwell, 1994).

These responses are expected to be species specific. Displacement also may be relative to the biology and ecology of species involved. Available studies have indicated that these reactions are likely to be short-term in nature. Although repeated, short-term disturbances can result in long-term impacts, seismic activity associated with the proposed lease sale typically would be limited to the open-water season within discrete areas and, therefore, the timeframe is limited in scope.

Fish distribution and feeding behavior can be affected by the sound emitted from airguns and airgun arrays (Turnpenny and Nedwell, 1994). Pelagic fish-catch rates and local abundance were reduced within 33 km of the airgun array for at least 5 days after shooting (Engås et al., 1993, 1996). There is no conclusive evidence for long-term or permanent horizontal displacement, and vertical displacement may be the short-term behavioral response (Slotte et al., 2004). Normal fish behavior likely returns when the airguns are turned off. The repopulation of the vacated area is reliant upon a diffusion-like process (Turnpenny and Nedwell, 1994).

Seismic surveys potentially may disrupt feeding activity and displace diadromous and marine fishes (i.e., capelin, cisco, and the whitefishes) from critical summer feeding areas along the Chukchi coast. While we cannot say with certainty the impacts of seismic surveys on fish feeding behavior, there is no present evidence that the behavioral impact of seismic surveys has a major effect on fish feeding, except perhaps in the immediate vicinity of an active survey vessel.

IV.C.1.d(2)(b)3 Impacts to Migration, Spawning, and Hatchling Survival. Most important to this issue are behavioral reactions that could result in disruption of migratory pathways or diminishing the availability of fish resources for subsistence resources (e.g., through fish abandoning important fishing grounds). For coastwise migratory fish species, acoustic disturbance may displace and disrupt important migratory patterns, habitat use, and life-history behaviors. The populations of many species move from one habitat to another and back again repeatedly during their life (Begon, Harper, and Townsend, 1990). The time-scale involved may be hours, days, months, or years.

For wide-ranging, migratory fish species, disturbance and displacement may disrupt important migratory and life-history behaviors and patterns or habitat areas. Seismic surveys conducted in Federal waters close to State waters, where many fishes migrate through to spawning sites along the coast or in anadromous streams of the Arctic, may disrupt or impede their migrations as fishes attempt to avoid airgun emissions. In addition, conducting more than one seismic operation simultaneously may influence the distribution of some juvenile and adult fishes, inadvertently herding them away from suitable habitat areas (e.g., nurseries, foraging, mating, spawning, migratory corridors) and concentrating many fishes in areas of unsuitable use.

Migratory species at risk of brief spawning delays include Pacific herring, capelin, Pacific salmon (chiefly pinks and chums), cisco, broad whitefish, and Pacific sand lance. Pacific herring and arctic cod are hearing specialists and are most likely the most acoustically sensitive species occurring in the Sale 193 area. They are, therefore, the most likely to exhibit displacement and avoidance behaviors of the arctic fishes occurring in the proposed sale area. Pacific salmon and the whitefish spawn in freshwater habitats of the Arctic coast. Pacific herring, capelin, and Pacific sand lance spawn on beaches or in nearshore waters.

The 3D/2D seismic surveys typically cover a relatively small area and only stay in a particular area for hours, thereby posing somewhat transient disturbances. Adverse effects to the migration, spawning, and hatchling survival of fish most likely would be temporary and localized, and only a moderate level of disturbance or displacement would occur.

IV.C.1.d(2)(b)4 Impacts from Vessel Noise. Engine-powered vessels may radiate considerable levels of noise underwater. Diesel engines, generators, and propulsion motors contribute significantly to the low-frequency spectrum. Much of the necessary machinery to drive and operate a ship produces vibration, within the frequency range of 10 Hz-1.5 kiloHertz, with the consequence of radiation in the form of pressure waves from the hull (Mitson and Knudsen, 2003). In addition to broadband propeller noise, there is a phenomenon known as “singing,” where a discrete tone is produced by the propeller, usually due to physical excitation of the trailing edges of the blades. This can result in very high tone levels within the frequency range of fish hearing. The overall noise of a vessel may emanate from many machinery sources. Pumps in particular often are significant producers of noise from vibration and, at higher frequencies, from turbulent flow. Sharp angles and high flow rates in pipework also can cause cavitation, and even small items of machinery might produce quite high levels of noise.

Mitson and Knudsen (2003) examined the causes and effects of fisheries research-vessel noise on fish abundance estimation and noted that avoidance behavior by a herring school was shown due to a noisy vessel; by contrast, there is an example of no reaction of herring to a noise-reduced vessel. They note a study wherein the FRV *Johan Hjort* was using a propeller shaft speed of 125 revolutions per minute, giving a radiated noise level sufficient to cause fish avoidance behavior at 560 m distance when traveling at 9 knots (kn), but it reduced to 355 m at 10 kn. Their Figure 5 shows that large changes in noise level occur for a small change in speed. Their data also suggest abnormal fish activity continues for some time as the vessel travels away from the recording buoy used in the study.

Vessel traffic associated with the seismic surveys, including the seismic-survey vessels and accompanying guard/chase boat or utility boat, are used chiefly during ice-free conditions. Vessel traffic may disturb some fish resources and their habitat during operations. Pacific salmon in the coastal and marine environment may be disturbed by vessel-traffic noise. However, vessel noise is expected to be chiefly transient as vessels are expected to be in transit. As discussed above, fishes in the immediate vicinity of such vessels are believed likely to avoid such noise perhaps by as much as several hundred meters. Based on consideration of this information, vessel noise is likely to be of negligible impact to fish resources.

IV.C.1.d(2)(b)5 Impacts from Anchor or Cable Deployment and Recovery. Anchoring by vessels is sometimes a necessary practice that locally may disturb the seafloor. In anchoring a vessel or in weighing anchor, fish resources may be crushed or injured during the practice. Anchors may not hold fast under some conditions and drag across the seafloor, damaging sessile organisms (e.g., sponges, corals, kelp) or their habitats (e.g., boulders).

Anchoring in fragile areas (e.g., kelp beds) likely would yield more damage to fish resources and habitat than anchoring offshore in sand or mud. There are few kelp beds in the Chukchi Sea, however, and these are located nearshore or in coastal lagoons, which is an unlikely site for a vessel to anchor unless necessary for safety. The magnitude of any damage to the seafloor would depend chiefly on exactly where anchors were placed, whether an anchor drags, and what an anchor might drag across. Direct impacts to benthic fish habitats would be restricted to the anchoring site, and these limited areas would be very small compared to the total area of benthic habitat available. These negative impacts are considered negligible.

IV.C.1.d(2)(b)6 Impacts from Coincidental Multiple Seismic Surveys. Given the limited evidence of avoidance and displacement from survey areas, the interaction of coincident multiple surveys may influence the distribution of some juvenile and adult fishes, inadvertently herding them away from suitable habitat areas (e.g., nurseries, foraging, mating, spawning, migratory corridors, access to overwintering sites) and concentrating many fishes in areas of unsuitable use. Such areas may not include suitable prey species or in densities to support the concentrated fishes. Displacement also may expose them to more predation than naturally experienced.

Concurrent seismic surveys may facilitate the stranding of some schooling or aggregated arctic fishes onto coastal or insular beaches in the proposed sale area. Such strandings may be more likely if multiple surveys were to spatially “box in” fishes along the shoreline and, thus, limit their avenues of retreat to less ensonified waters. Given that seismic surveys would be operating at least 17 km (10 mi) from shore, it is improbable that this would occur. A mitigation measure to separate concurrent or coincidental seismic survey operations (Sec. II.B.4) would largely alleviate all risk of fish strandings.

IV.C.1.d(2)(b)7 Impacts from Petroleum Spills. Fish resources could be exposed to accidentally spilled lubricating oil or diesel fuel from a vessel associated with seismic-survey operations or by a leaking or torn streamer array under tow by a vessel, if solid/gel streamers are not used. The liquid used to fill and provide streamer buoyancy usually is liquid paraffin that is biodegradable and evaporates very quickly. The MMS believes that the incidents involving the release of oil and fuel from vessels during refueling likely would be on the order of <5 gal. Full details on the effects of petroleum spills during seismic operations are in Section IV.C.1.d(3)(d)5).

IV.C.1.d(3) Effects from Exploration and Development. Once seismic surveys have indicated a potential source of oil, companies would delineate the field with exploratory wells. Once the field is defined and further evaluated, a production platform may be constructed to collect oil from wells around the platform. Potential impacts from these activities include additional impacts due to (a) noise, (b) discharges (produced water or drilling wastes), (c) platform and pipeline construction, and (d) oil spills.

IV.D.1.d(3)(a) Effects from Noise. Noise is produced during exploratory and production drilling. Drilling rigs (on two ice-bound gravel islands) produced noise (<200 Hz) that was recorded under sea ice out to a distance of 1.5 km. Moored drillship noise is predicted to attenuate to 115-120 dB at distances of 1-10 km. If fishes were disturbed by underwater noise emitted from the drill rigs, similar to reactions described in Section IV.C.1.d(2)(b) above, fish could move away from the source of the noise, effectively being displaced from a zone near the drill rig. The same situation would occur if construction activities produced underwater noise that disturbed fish.

Noise also is produced by vessels servicing exploration rigs and production platforms. Effects from these activities would be similar to those described under effects from seismic surveys (Sec. IV.C.1.d(2)(b)4) above), except that vessel activity would be less frequent and be generally restricted to an area between the drill site and a land-based support site.

IV.C.1.d(3)(b) Effects from Discharges. The primary source of the following description of discharge effects comes from Hurley and Ellis (2004). Exploration drilling occurs after seismic and other surveys

have determined the location and extent of a possible hydrocarbon bearing geological formation. Formations identified with remotely collected data may contain commercially viable hydrocarbon deposits or they may contain only water or hydrocarbons in quantities that are uneconomical to develop. Exploration drilling is the only way to confirm the presence of viable quantities of hydrocarbons in a prospective formation. In the event that hydrocarbons are found, further drilling of delineation wells may be required to further refine a prospect's potential for development or in order to establish the extent or commercial viability of a prospect. If development is to go ahead, several production wells may be drilled at the same site. Many aspects of drilling are common between offshore exploration and development drilling.

The potential for negative environmental effects for discharges other than drill wastes (e.g., bilge, ballast, grey water) was considered low since volumes discharged are small and the drilling unit is typically present on the drilling location for 60-90 days.

IV.C.1.d(3)(b)1) Physical Effects of Drill Wastes. The particulate fraction of discharged drilling wastes tends to settle on the seafloor so that its drift, dispersion and dilution are therefore generally lower than those of dissolved or buoyant discharges. Recent studies have indicated that drilling wastes can flocculate in seawater to form aggregates on the order of 0.5-1.5 millimeters in diameter with high settling velocities (Hurley and Ellis, 2004, citing Milligan and Hill, 1998) such that the bulk of drilling-mud discharges settle rapidly and can accumulate on the seabed (Hurley and Ellis, 2004 citing Muschenheim et al., 1995, Muschenheim and Milligan 1996). Based on chemical indicators of drilling muds such as barium in association with total petroleum hydrocarbons, large development projects with several wells at the same location had larger zones of detection (maximum 8,000 m) than single wells (maximum 1,000 m) at similar water depths.

Resuspension or deposition processes in the benthic boundary layer tend to concentrate particulate wastes in suspension near the seabed before eventually being dispersed by currents and waves (Hurley and Ellis, 2004, citing Muschenheim and Milligan, 1996). Regional and temporal variations in physical oceanographic processes, that determine the degree of initial dilution and waste suspension, dispersion and drift in the benthic boundary layer, have a large influence on the potential zone of influence of discharged drilling wastes. The spread of contaminants originating from drilling discharges by natural activities (storm events) can be quite extensive.

IV.C.1.d(3)(b)2) Biological Effects of Drill Wastes. The National Research Council (1983) concluded that impacts from drilling operations are most severe on benthic communities. Toxicity studies both in the laboratory and the field have focused on the fate of drilling waste discharges and their acute and chronic effects on the benthic infauna and epifauna and bottom-dwelling fish species. Most studies have focused on the physical effects of the clay fractions of the mud and/or the biological effects of the petroleum hydrocarbon contamination from the drilling fluids. Although observed impacts of drilling wastes generally been attributed to chemical toxicity or organic enrichment, there is increasing evidence to indicate that fine particles in drilling wastes contribute to the effects observed around drilling platforms. There are additional concerns about the potential for heavy metal pollution at petroleum exploration and development sites, including cadmium, lead, and mercury, which are found in drilling wastes (Hurley and Ellis, 2004, citing Cranford, 2001).

Heavy particles tend to settle near the discharge site and can form a pile on the seafloor. There is the potential that these cutting piles can smother benthic communities and result in artificial reef effects where the piles attract marine organisms and provide substrate for epifaunal animals such as crabs to colonize. The properties of the cuttings depend on the particle size, sorption capacity of the crushed rock, and on a number of technical factors. These factors, which ultimately determine the fate and longevity of the piles, include the type and formulation of drilling fluids, physiochemical parameters in the drilling zone, conditions of the mud and cuttings contact with extracted hydrocarbons, and methods of cuttings separation and treatment.

IV.C.1.d(3)(b)3) Persistence of Drill Wastes. Consistent zones of detection for drilling fluids and biological impacts for water-based muds were documented. Observations of the zone of detection of water-based muds suggest that average measured background levels are reached at 1,000-3,000 m. Some single-transect values have been elevated at up to 8,000 m. Maximum sediment concentrations of

synthetic-based muds were more localized than for water-based muds and were detected at distances ranging from 100-2,000 m from the discharge location. Biological impacts associated with the release of synthetic-based mud cuttings generally were detected at distances of 50-500 m from the well sites. Reductions in the abundance of a few species were detected over greater scales out to 1,000 m. While recovery of benthic communities generally was documented to occur within 1 year of completion, one case study documented that benthic species' richness and abundance were reduced at a distance of 50 m 2 years after exploratory drilling stopped (Hurley and Ellis, 2004, citing Candler et al., 1995). Overall, existing data suggest that these materials will be substantially degraded on a time scale between 1 and several years; however, the distribution and fate of these materials has not been extensively documented. The spatial area over which drilling muds are detected generally is greater than the area over which biological effects were documented.

IV.C.1.d(3)(c) Effects from Platform and Pipeline Construction. Noise-related disturbance effects to fish and direct loss or degradation of fish habitats likely would occur during construction in the marine environment (e.g., well sites, platform placement, pipeline trenching/burial) and at freshwater sites (pipeline and maintenance road construction). Exploration and production wells and a production platform footprint would result in a direct loss of seafloor habitats at the placement site, but these sites are relatively small compared to the amount of similar habitats available to salmon in the marine environment.

Offshore pipelines would be trenched as a protective measure against damage by ice in all water depths <165 ft (50 m). Trenching and pipelaying would take place during the short open-water season or during mid- to late winter, when landfast ice has stabilized. This trenching would create turbidity around the trenching site that, depending on the nature of the substrate, would remain for short-amounts of time or be moved offsite into other areas. At a coastal landfall, the pipeline likely would be elevated on a short gravel causeway to protect it against shoreline erosion. The specific locations of these facilities is unknown but would be evaluated under a subsequent NEPA document in an effort to minimize adverse habitat loss or degradation.

Furthermore, as described in Section I.E (Postlease Process), regulatory processes and jurisdictional authority concerning pipelines on the OCS and in coastal areas are shared by several Federal Agencies. Pipeline permit applications to MMS include the pipeline location drawing, profile drawing, etc. The MMS evaluates the design and fabrication of the pipeline and prepares a NEPA document in accordance with applicable policies and guidelines. The MMS prepares an EA and/or an EIS on all pipeline right-of-ways that go ashore. The FWS reviews and provides comments on applications for pipelines that are near certain sensitive biological communities. No pipeline route will be approved by MMS if any bottom-disturbing activities (from the pipeline itself or from the anchors of lay barges and support vessels) encroach on any biologically sensitive areas, such as stipulation-established No Activity Zones.

Post-landfall pipeline and associated maintenance-road alignment would depend on a number of factors, including cost and distance and avoidance of wetlands and other sensitive bird and wildlife habitats as dictated by Federal policy and law. These policies would guide mitigation efforts to reduce direct construction impacts to fish-bearing streams and lakes such as clear-span crossings, setbacks, and sediment- and erosion-control measures. Future facility locations would be evaluated on a site-specific basis to avoid or minimize adverse construction-related impacts to fish habitats that could be affected by the proposed sale. These construction activities are anticipated to result in temporary and/or localized adverse impacts to fish and fish habitats, but recovery would be expected to occur in fewer than three generations.

IV.C.1.d(3)(d) Effects from Oil Spills. Oil-spill effects on fishes from activities associated with the exploration, development, and production of oil resources in the Chukchi Sea could come from seismic surveys, vessel traffic, drilling discharges, offshore platforms, shore facilities, and pipelines.

Impacts to fish from oil spills could arise from a large spill from a platform or a pipeline, chronic small-volume oil spills, and cleanup activities. The general effects of oil on fish are described before assessing a large oil spill or chronic small-volume spills and cleanup activities.

IV.C.1.d(3)(d)1) General Effects of Oil Spills on Fish Resources. Petroleum is a complex substance composed of many constituents. These constituents vary in structural complexity, volatility, and toxicity to

organisms. A more detailed discussion of these differences, plus modes of release and factors affecting concentrations of oil in the water column, is found in Appendix A.

There are two general ways that oil spills adversely affect the abundance of a population: (1) through direct mortality or (2) through indirect impacts on reproduction and survival (Hilborn, 1996). In each case, the impacts might be followed by recovery to preimpact levels or by a long-term change in abundance. Additionally, long-term habitat change or a change in competitive or predation pressure could result in a long-term change in the distribution or abundance of a species.

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; 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 sublethal concentrations are encountered over a long-enough periods, fish mortality is likely to occur. Sublethal effects are likely and include changes in growth, feeding, fecundity, survival, and temporary displacement.

Oil spills can more specifically affect fish resources in many ways, including the following:

- cause mortality to eggs and immature stages, abnormal development, or delayed growth due to acute or chronic exposures in spawning or nursery areas; this may occur repeatedly if generation after generation continues to spawn and/or rear offspring in contaminated areas;
- impede the access of migratory fishes to spawning habitat because of contaminated waterways;
- alter behavior;
- displace individuals from preferred habitat;
- constrain or eliminate prey populations normally available for consumption;
- impair feeding, growth, or reproduction;
- contaminate organs and tissues and cause physiological responses, including stress;
- reduce individual fitness and survival, thereby increasing susceptibility to predation, parasitism, zoonotic diseases, or other environmental perturbations;
- increase or introduce genetic abnormalities within gene pools; and
- modify community structure that benefits some fish resources and detracts others.

Concentrations of petroleum hydrocarbons are acutely toxic to fishes a short distance from and a short time after a spill event (Malins, 1977; Kinney, Button, and Schell, 1969). The death of adult fish has occurred almost immediately following some oil spills (the *Florida* and *Amoco Cadiz*; Hampson and Sanders, 1969; Teal and Howarth, 1984). The majority of adult fish are able to leave or avoid areas of heavy pollution and, thus, avoid acute intoxication and toxicity. Evidence indicates that populations of free-swimming fish are not injured by oil spills in the open sea (Patin, 1999). In coastal shallow waters with slow water exchange, oil spills may kill or injure pelagic or demersal fish.

Lethal effects to adults may pose less threat to populations than damage to eggs and larvae or changes in the ecosystem supporting populations (e.g., Teal and Howarth, 1984). Floating eggs, and juvenile stages of many species can be killed when contacted by oil (Patin, 1999), regardless of the habitat.

The most serious concerns arise regarding the potential sublethal effects in fisheries resources, including commercially valued species, when exposed to chronic contamination within their habitats (Patin, 1999). The toxicity of oil pollution to aquatic populations has been seriously underestimated by standard short-term toxicity assays, and the habitat damage that results from oil contamination has been correspondingly underestimated (Ott, Peterson, and Rice, 2001). Research studies show that intertidal or shallow benthic substrates may become sources of persistent pollution by toxic polycyclic aromatic hydrocarbons (PAH's) following oil spills or from chronic discharges (Rice et al., 2000). Fish sublethal responses include a wide range of compensational changes (Patin, 1999). These start at the subcellular level and first have a biochemical and molecular nature. Recent research, mostly motivated by the *Exxon Valdez* oil spill (EVOS), has found that: (1) PAH's are released from oil films and droplets at progressively slower rates with increasing molecular weight leading to greater persistence of larger PAH's; (2) eggs from demersally spawning fish species accumulate dissolved PAH's released from oiled substrates, even when the oil is heavily weathered; and (3) PAH's accumulated from aqueous concentrations of <1 part per billion (ppb)

can lead to adverse sequelae (i.e., a secondary result of disease or injury) appearing at random over an exposed individual's lifespan (Rice et al., 2000). These adverse effects likely result from genetic damage acquired during early embryogenesis caused by superoxide production in response to PAH's. Therefore, oil poisoning is slow acting following embryonic exposure, and adverse consequences (e.g., prematurely truncated lifespan, impaired reproductive potential, unnatural physical or behavioral limitations) may not manifest until much later in life. The frequency of any one symptom usually is low, but cumulative effects of all symptoms may be considerably higher (Rice et al., 2000). For example, if chronic exposures persist, stress may manifest sublethal effects later in a form of histological, physiological, behavioral, and even population-level responses, including impairment of feeding, growth, and reproduction (Patin, 1999). Chronic stress and poisoning also may reduce fecundity and survival through increased susceptibility to predation, parasite infestation, and zoonotic diseases. These can affect the population abundance and, subsequently, community structure. For more information summarizing the various adverse effects (both individual and population level) to fish fauna or their habitats see Patin (1999, Tables 29 and 30).

IV.C.1.d(3)(d)2) Aspect of Life Histories Vulnerable to Effects of Oil. Several aspects of fish life histories may make arctic fish populations vulnerable to effects from spilled oil.

In particular, adult fish generally are unlikely to suffer great mortality as a result of an oil spill; however, diadromous fishes in the estuarine/nearshore, brackish water ecotone might be adversely affected by having their access to feeding, overwintering, or spawning grounds impeded. Effects of an oil spill could include increased swimming activity; decreased feeding; interference with movements to feeding, overwintering, or spawning areas; impaired homing abilities; and death of some adult or juvenile fishes. Fish also may suffer increased physiological stress when making the adjustment from fresh to brackish or marine water and vice versa that later result in mortality. Adverse effects are more likely for fishes that make extensive migrations from natal streams; for fishes with high fidelity to natal streams; and for fishes that overwinter in nearshore environments (such as the major river deltas). Recruitment or survival of fishes could be reduced by oil adversely affecting the spawning of adults, the development of early life-history stages repeated across generations, movement and feeding patterns of adults or juveniles, or overwintering juveniles or adults.

Larvae, eggs, and juvenile fishes generally are more sensitive to oil spills than are adult fishes. In particular, species with floating eggs (e.g., arctic cod) or eggs and larvae in more vulnerable positions (e.g., eggs and developing larvae of pink salmon or capelin on or proximate to contaminated substrates in the intertidal and/or shallow subtidal) could suffer extensive mortality (dependent on the amount and type of oil spilled, the areal extent of the spill, etc.). Nearshore demersal eggs or larval fishes spending time in coastal areas are the fish most vulnerable to adverse effects of spilled oil. These vulnerable categories include pink salmon, capelin, fourhorn sculpin, and snailfish, which can have great bursts of abundance in nearshore areas (e.g., Morrow, 1980, citing Andriyashev, 1954, Westin, 1970).

Growth, recruitment, and/or reproduction could be adversely affected, because oil may increase the already high mortality of larvae in the plankton by increasing the length of time in the plankton or by decreasing planktonic food.

Figure IV.C.1 models the potential pathways that an oil spill could impact spawning substrates and fish such as capelin and pink salmon. Fishes unable to detect a spill could experience direct mortality. Eggs laid in contaminated spawning habitats could experience direct mortality or sublethal effects. Sublethal effects could be manifested at subsequent lifestages. For example, young fish that survive to smolt could be undersized when entering the ocean and either become prey for larger fish that normally could not hunt them or, similarly, be unable to capture appropriately sized prey. If an oil spill occurred and decimated a year-class of young from one area, the effects likely would adversely influence successive generations' ability for recovery.

Eggs deposited in the proximity of the contaminated substrate over a series of years likely would be exposed to oil (PAH's) retained in the substrate, as PAH's in weathered oil can be biologically available for long periods and very toxic to sensitive lifestages, subsequently leading to lethal and sublethal effects to those offspring of successive generations. It is not known what such a behavioral response may have on the dynamics of the population; however, the spawning site likely would be unavailable for use for multiple generations, depending on the sensitivity of the capelin to detecting contaminated substrates and how long

the oil persists in the localized habitat. It is likely that the affected population would decline and require three or more generations to return to its former status. The likely results are that fewer juvenile fish survive, so that recruitment from the early lifestages is reduced, and adult populations decline and may not be replaced at sustainable levels.

Fishes able to detect and avoid a contaminated spawning area could use unsuitable or more distant alternative spawning sites resulting in high egg/larvae loss or other potential energetic costs that affect fecundity.

IV.C.1.d(3)(d)3) Species-Specific Effects. This section considers, consecutively, effects on diadromous species; marine pelagic species; demersal species; capelin, a marine species that spawns along the coast; and Pacific salmon.

IV.D.1.d(3)(d)3)a) Diadromous Fishes. Diadromous fishes of importance because of abundance, life history, or use in domestic fisheries are least cisco, arctic char, and broad whitefish. A number of diadromous species in the region have complicated life-history patterns that are not fully understood. For the most part, diadromous fishes in the Chukchi Sea, unlike Pacific salmon, spend the major part of their lives in freshwater rivers and lakes but undertake seasonal migrations to coastal regions in the ice-free season to feed or overwinter. The details of foraging migrations of the more abundant diadromous fishes appear to vary not only among species but among life-history stages of the same species. These differences in migratory habits lead to spatial and temporal differences in the relative abundance of different species and lifestages in the nearshore zone (Bond, 1987; Cannon and Hachmeister, 1987). Thus, an oil spill contacting the nearshore environment might affect various species and age classes of anadromous fishes as they move to feeding, overwintering, or spawning grounds. Because most diadromous fishes make spawning runs and outmigrations over a period of time, it is unlikely that an entire year-class would be lost as it moved toward a spawning stream or migrated out of a stream. Even if fish were held up because a delta area was contacted by oil, it is unlikely that the major river deltas would be entirely contacted, given the broad expanses of the deltas, outflow, and the estimated size of a $\geq 1,000$ bbl spill. It is most likely that few channels of these rivers would be affected and, thus, only a portion of the spawning run or a portion of the variously aged fish in a population would be affected.

Effects on diadromous species while they are dispersed in the nearshore zone are expected to be moderate. However, if they are contacted while concentrated or aggregated in delta regions, high effects are possible. Because oil spills are more likely to affect diadromous species while they are dispersed in the nearshore rather than during the shorter timeframe in which they are aggregated, a moderate effect is most likely for these species.

IV.C.1.d(3)(d)3)b) Marine Pelagic Species. Fish populations having basically pelagic distributions are expected to be little affected by spills (with the exceptions of pink salmon, capelin, and the cryopelagic species); most of them are thought to have broad distributions in the proposed sale area. Even if larvae, which generally are more sensitive, are affected, only a portion of those in the ichthyoplankton would be harmed; and the effects would be difficult to determine, given the high natural mortality of fish larvae and the natural variability of recruitment from year to year. If some adults were killed, recruitment into the population might not be affected, because for marine fish species having planktonic larvae, there is little correlation between the size of the adult population and recruitment. Effects on recruitment would be particularly difficult to assess, because very few studies of offshore fishes have been made. Effects might be most noticeable if predators of these pelagic fishes decline in abundance or fail to reproduce, but the cause of such an effect might not be apparent. In general, effects of a single spill $\geq 1,000$ bbl are not expected to exceed moderate for pelagic fishes.

IV.C.1.d(3)(d)3)c) Marine Demersal Species. Demersal fishes in oceanic waters are not expected to be affected by oil spills, as the likelihood of oil reaching the sea bottom in the oceanic province in any appreciable amounts or over an extensive area is very small. However, demersal coastal fishes inhabiting shallow, soft-bottomed areas could be affected by a spill, if the water column is mixed and oil comes to contaminate sediments and/or in the shallows (Moulton, Fawcett, and Carpenter, 1985; Craig and Halderson, 1981). Because some species have broad distributions in the proposed sale area, and effects of spills are expected to be relatively localized and unlikely to affect the deeper benthos, effects on the regional populations of demersal fishes are expected to be moderate.

Arctic Cod. For arctic cod, a species that is patchy in distribution, has floating eggs, and associates with ice cover during early life-history stages, it may be extremely difficult to determine the effect of an oil spill. Adult arctic cod have been reported to suffer 50% mortality (LC_{50}) at concentrations of 1,569 parts per million +0.004 oil over an 8-day period (USDOC, NOAA, NMFS, NWAFC, 1979, as cited by Starr, Kawada, and Trasky, 1981).

The abundance of arctic cod sometimes is very high in coastal surface waters. Jarvela and Thorsteinson (1999) found annual mean densities of arctic cod in the 0- to 2-m-depth interval of their study area as 50.6 per 1,000 m^3 in 1990, and 1.8 per 1,000 m^3 in 1991. Their mean densities of age-0 arctic cod in the surface waters during 1990 and 1991 were within the range of previously reported late summer-fall values, both within the study area and elsewhere in the North American Arctic. In the Prudhoe Bay area, estimated densities were 14.2/1,000 m^3 in 1979 (Jarvela and Thorsteinson, 1999, citing Tarbox and Moulton, 1980) and 15.5/1,000 m^3 in 1988 (Jarvela and Thorsteinson, 1999, citing Houghton and Whitmus, 1988). In Simpson Lagoon, monthly mean surface densities ranged between 0 and 82/1,000 m^3 in 1977 and 1978 (Jarvela and Thorsteinson, 1999, citing Craig and Griffiths, 1978, Craig et al., 1982). Jarvela and Thorsteinson (1999) also noted: (1) the size composition of individual catches indicates that arctic cod generally were segregated into discrete size or age groups; (2) a few large catches of arctic cod and capelin during the later period constituted most of the annual catch in each year; and (3) the densities of all species except capelin declined from 1990-1991.

Although arctic cod can be extremely abundant in nearshore lagoonal areas, the importance of nearshore versus offshore environments to the lifecycle is not known (Craig et al., 1982). Although it is known that juvenile arctic cod associate with floating ice, it is unknown to what degree this association contributes to the development and survival of young fishes later recruiting to the breeding population. If early life-history stages of arctic cod were concentrated in nearshore environments, in patches in the open ocean, or under floating ice, they certainly would be more vulnerable to effects from an oil spill impacting such habitats. Even though arctic cod are vulnerable to effects from oil spills because they have floating eggs, are cryopelagic, and prone to segregating into discrete size or age groups, the effect of one spill $\geq 1,000$ bbl on this species is expected to be moderate.

Capelin. Capelin spawn in coastal sandy areas in the Chukchi Sea in June, July, and August. They are highly specific with regard to spawning conditions, making them highly vulnerable to an oil spill affecting their spawning habitat. At spawning grounds, capelin segregate into schools of different sexes. The general pattern seems to be that ripe males await opportunities to spawn near the beaches, while large schools, mainly composed of relatively inactive females, remain for several weeks off the beaches in slightly deeper water (i.e., staging area). As these females ripen, individuals proceed to the beaches to spawn. Thus, most males remain in attendance near the beaches and join successive small groups of females that spawn and depart from the area. Capelin spawn at about 2 years of age, and many individuals die after spawning (Jangaard, 1974).

Capelin eggs are demersal and attach to gravel on the beach or on the sea bottom. The incubation period varies with temperature, and hatching has been demonstrated to occur in about 55 days at 0 °C, 30 days at 5 °C, and 15 days at 10 °C. Hatching of capelin eggs has been shown to be negatively affected by concentrations of 10-25mg/L (100-250 ppb) of crude oil (Johannessen, 1976). Capelin spawning on substrates contaminated by spilled oil expose their eggs and larvae to PAH's that likely would result in acute and chronic lethal and sublethal effects that decrease capelin abundance and delay recovery of the affected population(s) for three or more generations. Direct and indirect adverse impacts affecting one or more generations of capelin are likely to change vital rates; changed vital rates within populations are modeled to significantly affect population dynamics (Koons, Rockwell, and Grand, 2006).

Newly hatched capelin larvae soon assume a pelagic existence near the surface, where they remain until winter cooling sets in, when they move closer to the sea bottom until waters warm again in spring. Jarvela and Thorsteinson (1999) noted that coastal waters appear to be an important habitat for age-0 capelin throughout the summer, whereas older fish seem to be present for comparatively brief periods during spawning runs. However, their study was not designed to investigate actual spawning sites. An oil spill occurring in coastal waters after a spawning event likely would adversely impact newly hatched capelin, resulting in acute mortality of much or most of the affected population's cohort. Should the oil spill

subsequently impact the spawning substrates of the affected population, there could be significant adverse impacts.

An oil spill occurring in coastal waters during summer likely would adversely impact feeding activity of capelin. Some larval and juvenile capelin not experiencing acute mortality as a result of exposure to oil may directly or indirectly have their feeding inhibited and starve later (e.g., during winter), because they were unable to consume sufficient sustenance during summer to carry them over to the next feeding period (e.g., the following summer).

Also unknown are the distribution and abundance of spawning sites used by capelin in the Alaskan Arctic. The type of sandy gravel beach used by capelin occurs over much of the Chukchi Sea coastline. Effects on capelin are expected to be potentially adverse at any beach location contacted by a large spill and could last for three or more generations before recovery to their former status at those specific locations; however, the loss of capelin to the overall regional capelin population would be insignificant.

Salmon. As previously described (Secs. III.B.2.d(2) and (3)), both chum and pink salmon runs exist in several in coastal streams along the northeastern Chukchi Sea coast. Species-specific effects are largely expected to be similar, so we describe pink salmon here.

Most pink salmon spawn within a few miles of the coast, and spawning within the intertidal zone or the mouth of streams is very common. Available data suggest that pink salmon are more abundant in even-numbered years, as is the general pattern for this species in western Alaska (Craig and Halderson, 1986, citing Heard, 1986). This pattern may be a manifestation of the pink salmon lifecycle (they spawn at 2 years of age and then die).

An oil spill impacting the Chukchi Sea coast may adversely impact spawning and/or rearing habitat used by pink salmon. An oil spill contaminating intertidal spawning substrate likely would result in acute and chronic direct and indirect adverse impacts that decreases the affected population's abundance and delays their recovery, requiring three or more generations to recover to their former status in the local area impacted by the oil spill. Affected population(s) at the site of an oil spill may be extirpated, as PAH's in weathered oil can be biologically available for long periods and very toxic to sensitive lifestages. If an oil spill were to reach a pink salmon-spawning area, few juvenile pink salmon may survive, potentially resulting in lower recruitment from the early lifestages. Adult populations at that location may not be replaced to pre-oil-spill numbers.

Pink salmon populations at the site of an oil spill also may be adversely affected indirectly through effects on food sources, but these effects are extremely difficult to study or predict. Because no evidence suggests significant biomagnification of oil through trophic linkages (Varanasi and Malins, 1977; Cimato, 1980), adult fish may be little affected by tainted food. However, larval or juvenile salmon may be affected by decreased feeding opportunities, slower growth rates, and increased predation (Fig. IV.C-1).

IV.C.1.d(3)(d)4 Oil-Spill Impacts to Fish Resources - Lessons from the Exxon Valdez Oil Spill.

Long-term ecosystem responses. Most recently, Peterson et al. (2003) describe the long-term ecosystem response to the EVOS. Peterson et al. (2003) stated:

The ecosystem response to the 1989 spill of oil from the Exxon Valdez into Prince William Sound, Alaska, shows that current practices for assessing ecological risks of oil in the oceans and, by extension, other toxic sources should be changed. Previously, it was assumed that impacts to populations derive almost exclusively from acute mortality. Unexpected persistence of toxic sub-surface oil and chronic exposures in the Alaskan coastal ecosystem, even at sublethal levels, have continued to affect wildlife. Delayed population reductions and cascades of indirect effects postponed recovery. Development of ecosystem-based toxicology is required to understand and ultimately predict chronic, delayed, and indirect long-term risks and impacts.

...uncertainties do little to diminish the general conclusions: oil persisted beyond a decade in surprising amounts and in toxic forms, was sufficiently bioavailable to induce chronic biological exposures, and had long-term impacts at the population level. Three major pathways of induction of long-term impacts emerge: (i) chronic persistence of oil, biological exposures, and population

impacts to species closely associated with shallow sediments; (ii) delayed population impacts of sublethal doses compromising health, growth, and reproduction; and (iii) indirect effects of trophic and interaction cascades, all of which transmit impacts well beyond the acute-phase mortality.

Conclusions by Peterson et al. (2003) specifically pertinent to fish resources include:

- Chronic exposures of sediment-affiliated species.
- Chronic exposures enhanced mortality for years.
- After the spill, fish embryos and larvae were chronically exposed to partially weathered oil in dispersed forms (citing Murphy et al., 1999).
- Laboratory experiments showed that these multi-ringed polycyclic aromatic hydrocarbons (PAH's) from partially weathered oil at concentrations as low as 1 ppb are toxic to pink salmon eggs exposed for the months of development and to herring eggs exposed for 16 days (citing Marty, Heintz, and Hinton, 1997, Heintz et al., 2001).
- This process explains the elevated mortality of incubating pink salmon eggs in oiled rearing streams for at least 4 years after the oil spill. (citing Bue, Sharr, and Seeb, 1998).

Sublethal exposures leading to death from compromised health, growth, or reproduction:

- Oil exposure resulted in lower growth rates of salmon fry in 1989 (citing Rice et al., 2001), which in pink salmon reduce survivorship indirectly through size-dependent predation during the marine phase of their life history (citing Willette et al., 2000).
- After chronic exposure as embryos in the laboratory to < 20 ppb total PAH's, which stunted their growth, the subsequently marked and released pink salmon fry survived the next 1.5 years at sea at only half the rate of control fish (citing Heintz et al., 2001).
- In addition, controlled laboratory studies showed reproductive impairment from sublethal exposure through reducing embryo survivorship in eggs of returning adult pink salmon that had previously been exposed in 1993 to weathered oil as embryos and fry (citing Heintz et al., 1999).
- Abnormal development occurred in herring and salmon after exposure to the Exxon Valdez oil (citing Carls et al., 2001; Marty, Heintz, and Hinton, 1997).

Cascades of indirect effects:

- Indirect effects can be as important as direct trophic interactions in structuring communities (citing Schoener, 1993).
- Cascading indirect effects are delayed in operation because they are mediated through changes in an intermediary.
- Perhaps the two generally most influential types of indirect interactions are (i) trophic cascades in which predators reduce abundance of their prey, which in turn releases the prey's food species from control (citing Estes et al., 1995) and (ii) provision of biogenic habitat by organisms that serve as or create important physical structure in the environment (citing Jones et al., 1994).
- Current risk assessment models used for projecting biological injury to marine communities ignore indirect effects, treating species populations as independent of one another (citing Peterson, 2001; Rice et al., 2001).
- Indirect interactions lengthened the recovery process on rocky shorelines for a decade or more (citing Peterson, 2001).
- Expectations of rapid recovery based on short generation times of most intertidal plants and animals are naive and must be replaced by a generalized concept of how interspecific interactions will lead to a sequence of delayed indirect effects over a decade or longer (citing Peterson, 2001).
- Indirect interactions are not restricted to trophic cascades or to intertidal benthos. Interaction cascades defined broadly include loss of key individuals in socially organized populations, which then suffer subsequently enhanced mortality or depressed reproduction.
- Ecologists have long acknowledged the potential importance of interaction cascades of indirect effects. New synthesis of 14 years of Exxon Valdez oil spill studies documents the contributions of delayed, chronic, and indirect effects of petroleum contamination in the marine environment.

- Old paradigm in oil ecotoxicology – oil toxicity to fish: oil effects solely through short-term (~4 day) exposure to water-soluble fraction (1- to 2-ringed aromatics dominate) through acute narcosis mortality at parts per million concentrations.
- New paradigm in oil ecotoxicology – oil toxicity to fish. Long-term exposure of fish embryos to weathered oil (3- to 5- ringed PAH's) at ppb concentrations has population consequences through indirect effects on growth, deformities, and behavior with long-term consequences on mortality and reproduction.

General Effects Applicable all Fish Species: Carls et al. (2005) concluded that: (1) induction of cytochrome P4501A (CYP1A) is statistically correlated with adverse effects at cellular, organism, and population levels in pink salmon and can be used to predict these responses; (2) exposure of pink salmon embryos and larvae to oil caused a variety of lethal and sublethal effects; and (3) the combined results from a series of embryo-larval exposure experiments spanning 5 brood years are consistent and demonstrate that CYP1A induction is related to a variety of lethal and sublethal effects, including abnormalities, reduced growth and diminished marine survival. CYP1A induction has been observed in many species and in many of the same tissues (Carls et al., 2005, citing, e.g., Sarasquete and Segner, 2000, Stememan et al., 2001).

Short et al. (2003) concluded that habitat damage resulting from oil contamination is underestimated by acute toxicity assays. They describe that nearshore substrates oiled by spills may become persistent pollution sources of toxic PAH's. Their findings from EVOS research include: (1) PAH's are released from oil films and droplets at progressively slower rates with an increasing molecular weight leading to greater persistence of larger PAH's; (2) eggs from demersally spawned fish species accumulate dissolved PAH's released from oiled substrates, even when the oil is heavily weathered; and (3) PAH's accumulated by embryos from aqueous concentrations of <1 nanogram per liter (ng/L) can lead to adverse sequelae appearing at random over the lifespan of an exposed cohort, probably as a result of damage during early embryogenesis. They conclude that oil is a slow-acting poison, and that toxic effects may not manifest until long after exposure (see Fig. IV.C-1). Several highly pertinent points taken from Short et al. (2003) include:

- Fish and oil do not mix...the threat is not from acutely toxic concentrations that result in immediate fish kills, but in the more subtle effects of low-level oil pollution to sensitive life stages. Incubating eggs are very sensitive to long-term exposure to PAH concentrations because they may sequester toxic hydrocarbons from low or intermittent exposures into lipid stores for long periods and because developing embryos are highly susceptible to the toxic effects of pollutants (citing Mary et al., 1997, Carls et al., 1999, Heintz et al., 1999, 2000). PAH's in weathered oil can be biologically available for long periods and very toxic to sensitive life stages. The result is that fewer juvenile fish survive, so that recruitment from the early life stages is reduced and adult populations may not be replaced at sustainable levels. Eventually, adult populations may gradually decline to unsustainable numbers.
- Streams and estuaries sustain the vulnerable early developmental life stages of many fish species.... Herring spawn their eggs in areas of reduced salinities, salmon early life stages use both stream and estuary for much of the first year of life, and the juveniles of many marine species use the estuaries for nursery grounds. The very qualities of these natal and rearing habitats that provide protection from predators also make both the habitat and, by extension, the species vulnerable to pollution. The sediments of salmon streams and many nearshore estuaries are capable of harboring oil for extended periods with slow release.
- Habitats used by demersally spawning fish such as salmon, herring, and capelin are particularly vulnerable to the effects of oil coming ashore on beaches and the spawning gravels of streams.
- Fish natal and rearing habitats are clearly vulnerable to oil poisoning from chronic discharges under the current regulatory framework. Oil discharges into these habitats are covered by water quality standards based on acute LC₅₀ results for more tolerant lifestages, which may seriously underestimate cumulative adverse effects, even when presumably conservative safety factors of 0.01 are applied. These water quality standards need to be revised if we are to protect these habitats.
- Chronic pollution seldom results in floating fish carcasses. Instead, there is continued habitat contamination, erosion of populations, and when coupled over time with other events such as hard winters, other habitat loss, increased in predators or fishing, decreases in food availability at a

critical life stage, etc. may eventually result in unsustainable populations in high impact environments. Species with life history strategies that rely on streams or estuaries for reproduction are most vulnerable.

In the absence of further laboratory study with other fish species, Short et al. suggested a toxicity threshold of approximately 1 ng/L of aqueous PAH's for habitats where fish eggs and larvae rear, derived from studies on sensitive early life stages of pink salmon and Pacific herring. They also recommended that government standards for dissolved aromatic hydrocarbons should be revised to reflect this threshold for protection of critical life stages and habitats of fish.

Demersal Fish: Demersal marine fishes, particularly those associated with nearshore waters, are known to be impacted by oil spills. Demersal fishes may at times inhabit the benthos or pelagic waters. Vertical changes in depth may be responses to factors such as light conditions and foraging opportunities. For example, Pacific sand lance inhabit the water column nearshore during the day but at night, they bury themselves in soft bottom sediments. They also are known to overwinter by burying in sediments, with a preference for fine or coarse sand substrate. This makes them particularly vulnerable to oil spills impacting nearshore areas.

Demersal fishes inhabiting oil-polluted areas may suffer similar lethal and sublethal effects (e.g., egg mortality, developmental aberrations, reduced survival, etc.) as reported for pelagic finfishes, although not necessarily of the same magnitude. For example, Moles and Norcross (1998) found that juvenile yellowfin sole, rock sole, and Pacific halibut experienced reduced growth following 30-90 days of exposure to sediments laden with Alaska North Slope crude oil. Changes in fish health bioindicators after 90 days—i.e., increases in fin erosion, liver lipidosis, gill hyperplasia, and gill parasites—coupled with decreases in macrophage aggregates, occurred at hydrocarbon concentrations (1,600 micrograms per gram) that reduced growth 34-56% among the demersal fishes. Moles and Norcross (1998) concluded that: (1) chronic hydrocarbon pollution of nearshore nursery sediments could alter growth and health of juvenile flatfishes; and (2) recruitment of juveniles to the fishery may decline because of increased susceptibility to predation and slower growth.

Yelloweye, quillback, and copper rockfish examined for histopathological lesions and elevated levels of hydrocarbons in their bile after the EVOS indicated significant differences between oiled and control locations (Hoffman, Hepler, and Hansen, 1993). Additionally, at least five rockfish examined were killed by exposure to oil. While the authors noted no population-level effect in these species, these data indicate spilled oil reached and exposed demersal fishes to both sublethal and lethal toxic effects.

Some demersal or pelagic species are sensitive to oiled substrates, and may be displaced from preferred habitat that is oiled. Other species may not be sensitive to contaminants and use contaminated sites, thereby prolonging their exposure to contaminants. Pinto, Pearson, and Anderson (1984) found that sand lance avoided sand contaminated with Prudhoe Bay crude oil in an experimental setting. Moles, Rice, and Norcross (1994) exposed juvenile rock sole, yellowfin sole, and Pacific halibut to laboratory chambers containing contaminated mud or sand offered in combination with clean mud, sand, or granule. The fishes were able to detect and avoid heavily oiled (2%) sediment but did not avoid lower concentrations of oiled sediment (0.05%). Oiled sediment was favored over nonoiled sediment, if the nonoiled sediment was of the grain size not preferred by that species. Oiled sand or mud was always preferred over nonoiled granule. The authors concluded that the observed lack of avoidance at concentrations likely to occur in the environment may lead to long-term exposure to contaminated sediment following a spill.

Hydrocarbon exposure in demersal fishes often results in an increase in gill parasites (Khan and Thulin, 1991; MacKenzie et al., 1995). Moles and Wade (2001) experimentally tested adult Pacific sand lance's susceptibility to parasites when exposed to oil-contaminated sediments for 3 months. They found that sand lance exposed to highly oiled substrates had the greatest mean abundance of parasites per fish. Chronic exposure to harmful pollutants such as hydrocarbons coupled with increased parasitism degrades individual fitness and survival.

Species-Specific Effects. Oil-spill impacts to Alaskan fishes are best known for populations of Pacific salmon and Pacific herring that were impacted by the EVOS. Because Pacific salmon and Pacific herring occur in the Alaskan Chukchi Sea, studies of the impacted populations are useful to elucidate potential impacts that an oil spill may have on arctic populations.

Pacific Salmon: Salmon are able to detect and avoid hydrocarbons in the water (Weber et al., 1981), although some salmon may not avoid oiled areas and become temporarily disoriented but eventually returning to their home stream (Martin, 1992). Adult salmon remain relatively unaffected by oil spills and are able to return to natal streams and hatcheries, even under very large oil-spill conditions, as evidenced by pink and red salmon returning to Prince William Sound and red salmon returning to Cook Inlet after the EVOS. When oil from the EVOS entered Cook Inlet, the Alaska Department of Fish and Game closed the sockeye salmon commercial fishery in Cook Inlet. This evidently resulted in overescapement of spawning fish in the Kenai River system for the third consecutive year. Overescapement in 1987 was due to a previous spill and, in 1988 there was a naturally high escapement. Salmon smolts appeared to decline. Although the mechanism for the apparent decline in smolt abundance is uncertain, the result of overescapement and too many salmon fry to be supported by the available prey may be the cause. The extent of the decline was speculative. Managers originally predicted that adult salmon returns in 1994 and 1995 would be below escapement goals, but the 1994 returns were three times that forecasted. Escapement goals were met for 1995, and commercial fisheries were operating. The *Exxon Valdez* Oil Spill Trustee Council listed pink and red salmon as recovered in 2002, 13 years after the spill.

Many fish species are most susceptible to stress and toxic substances during the egg and larval stages than at the adult stage. Intertidal areas contaminated by spilled oil may persist for years and represent a persistent source of harmful contaminants to aquatic organisms. Contamination of intertidal spawning-stream areas for pink salmon caused increased embryo mortality and possible long-term developmental and genetic damage (Bue, Sharr, and Seeb, 1998). The embryo, a critical stage of salmon development, is vulnerable because of its long incubation in intertidal gravel and its large lipid-rich yolk, which will accumulate hydrocarbons from chronic, low-level exposures (Marty, Heintz, and Hinton, 1997; Heintz, Short, and Rice, 1999). Pink salmon (often intertidal spawners) embryos in oiled intertidal stream areas of Prince William Sound continued to show higher mortality than those in nonoiled stream areas through 1993, more than 4 years after the oil spill, but appeared to recover in 1994 (Bue, Sharr, and Seeb, 1998).

Experiments conducted by Heintz, Short, and Rice (1999) demonstrate that aqueous-total PAH concentrations as low as 1 ppb derived from weathered EVOS oil can kill pink salmon embryos localized downstream from oil sources. Their study also found a 25% reduction in survival during incubation of brood fish exposed to 18 ppb. Other studies examining egg and fry survival showed no difference between oiled and nonoiled locations (Brannon et al., 1993) except in two cases—one that showed higher mortality at a nonoiled stream, and another that showed higher mortality at the high-tide station of an oiled stream. These studies did not measure PAH's in stream water or in salmon embryos, were statistically underpowered, and were insufficient in duration to test for the manifestation of adverse effects from low-level PAH exposures (Murphy et al., 1999). Results published by Murphy et al. (1999) and Heintz, Short, and Rice (1999) contradict other scientists' conclusions that PAH concentration in spawning substrate after the spill was too low to adversely affect developing salmon (i.e., Brannon et al., 1995; Maki et al., 1995; Brannon and Maki, 1996).

Several studies demonstrated indirect and chronically adverse effects of oil to intertidal fish at levels below the water quality guidelines of 15 ppb. Experiments conducted by Heintz, Short, and Rice, (1999) demonstrate that between the end of chronic exposure to embryonic salmon and their maturity, survival was reduced by another 15%, resulting in the production of 40% fewer mature adults than the unexposed population. They concluded the true effect of the exposure on the population was 50% greater than was concluded after evaluating the direct effects. Additional research found that fewer exposed fish from one experimentally exposed egg brood survived life at sea and returned as mature adults compared to unexposed fish (Heintz et al., 2000). Moreover, Heintz et al. (2000) experimental data show a dependence of early marine growth on exposure level; unexposed salmon increased their mass significantly more than salmon exposed to crude oil as embryos in eggs. Heintz et al. (2000) concluded that exposure of embryonic pink salmon to PAH concentrations in the low parts per billion produced sublethal effects that led to reduced growth and survival at sea. Studies, therefore, indicate that examination of short-term consequences underestimate the impacts of oil pollution (Heintz et al., 2000; Rice et al., 2000; Ott, Peterson, and Rice, 2001).

Carls et al. (2005) studied CYP1A-induction pink salmon embryos exposed to crude oil and linked adverse effects at the cellular, organism, and population levels. Cytochrome 4501A is a particular group of mono-oxygenase enzymes that mediates oxidation of petroleum hydrocarbons and other xenobiotics, thereby

facilitating their excretion (Wiedmer et al., 1996, citing Jimenez and Stegeman 1990). Carls et al. (2005) found that CYP1A induction (i.e., an exposure that introduces one to something previously unknown) indicates that long-term damage is probable, leading to reduced survival. In similar exposures to PAH with pink salmon embryos, earlier studies found both short- and long-term effects, including poor adult returns when embryos were exposed to similar dose levels (Carls et al., 2005, citing Marty et al. 1997; Heintz, Short, and Rice, 1999; Heintz et al., 2000). Specifically, depressed fry growth and significantly reduced marine survival were observed after exposure of pink salmon embryos to <5.2 micrograms per liter aqueous-total PAH concentrations (Carls et al., 2005, citing Heintz et al. 2000). Tests confirm that long-term consequences can be expected from low exposure doses to embryos. Theirs and other studies demonstrate that CYP1A induction in embryos is linked to reduced marine survival and, therefore, population-level effects.

Reduced growth potential in the marine environment, caused by toxic action in oil-exposed embryos, probably is the key functional change that leads to the distinct survival disadvantage and fewer returning adult spawners (Carls et al., 2005). Rapid fry growth after emigration to the marine environment is important to escape mortality from size-selective predation (Carls et al., 2005, citing Parker, 1971, Healey 1982, Hargreaves and LeBrasseur, 1985), thus, placing oil-exposed fish at a disadvantage. In oil-exposure tests with pink salmon embryos followed by released fry, reduced marine survival of pink salmon adults has been directly observed in 3 different brood years (1993, 1995, and 1998; Carls et al., 2005, citing Heintz et al., 2000). Depressed marine survival was consistently correlated with depressed growth rate 4-10 months after emergence and was a more sensitive measure of significant response in 1995 fish than growth rate.

Carls et al. (2005) determined that the model of activity demonstrated by their study is consistent with a similar cascade of effects described in Prince William Sound after the EVOS. In juvenile pink salmon in marine water, CYP1A was induced by oil, and growth slowed (Carls et al., 2005, citing Carls et al., 1996, Wertheimer and Celewycz, 1996, Willette, 1996). Geiger et al. (1996, as cited by Carls et al., 2005) estimated that approximately 1.9 million wild pink salmon failed to return as adults in 1990 because of poor growth and reduced survival (about 28% of the potential wild-stock production in the southwest portion of Prince William Sound). Pink salmon embryos incubating in the intertidal reaches of streams were exposed to PAH from oil-coated intertidal sediment; CYP1A was induced and survival was significantly reduced through 1993 (Carls et al., 2005, citing Bue et al., 1996, 1998, Wiedmer et al., 1996, Craig et al., 2002, Carls et al., 2003). Gieger et al. (1996, as cited by Carls et al., 2005) estimated that 60,000-70,000 pink salmon failed to return as adults in 1991 and 1992, respectively, as a result of toxic exposure. Hence, the laboratory study is consistent with these field data.

Exposure to PAH during the earliest stages of development may increase significantly the risk of damage to developing embryos, consistent with the general observation that early lifestages are highly vulnerable to pollutants (Carls et al., 2005, citing, e.g., Moore and Dwyer, 1974) which can have immediate, secondary, and delayed effects. Carls et al. (2005) reported some macroscopic abnormalities that were positively correlated with total PAH exposure. Abnormalities that were positively correlated with exposure were ascites, bulging eyes, malformed head, short opercular plates, external hemorrhaging, mouth or jaw malformation, and deformed caudal fin. Unusual pigmentation and tumors were negatively correlated with exposure, probably because embryos with these developmental problems were less likely to survive oil exposure (Carls et al., 2005). Permanent multiple defects are likely to have lasting consequences, such as poorer growth and marine survival (Carls et al., 2005, citing, e.g., Heintz et al., 2000). Information regarding impacts from the EVOS on populations of pink salmon are relevant to this assessment, because other salmon species (e.g., chum and coho) inhabit the coastal habitats of the Chukchi Sea and the biological responses of salmon species to PAH's and oil likely are similar.

Pacific Herring: Some Pacific herring stocks of the Gulf of Alaska were impacted appreciably by past oil spills. The EVOS occurred a few weeks before Pacific herring spawned in Prince William Sound. A considerable portion of spawning habitat and staging areas in Prince William Sound were contaminated by oil. Adult herring returning to spawn in Prince William Sound in 1989 were relatively unaffected by the spill and successfully left one of the largest egg depositions since the early 1970's. Total herring-spawn length for 1989 was 158 km, with 96% in nonoiled areas, 3% in areas of light to very light oiling, and only 1% in areas characterized as moderate to heavy oiling (Pearson, Mokness, and Skalski, 1993). About half of the egg biomass was deposited within the oil trajectory, and an estimated 40-50% sustained oil exposure

during early development (Brown et al., 1996). Other researchers estimated that more than 40% of the areas used by the Prince William Sound stocks for spawning and more than 90% of the nearshore nursery areas were exposed to spilled crude oil (Biggs and Baker, 1993).

McGurk and Brown (1996) tested the instantaneous daily rates of egg-larval mortality of Pacific herring at oiled and nonoiled sites; they found that the mean egg-larval mortality in the oiled areas was twice as great as in the nonoiled areas, and larval growth rates were about half those measure in populations from other areas of the North Pacific Ocean. Norcross et al. (1996) collected Pacific herring larvae throughout Prince William Sound in 1989 following the EVOS. They found deformed larvae both inside and outside of areas considered as oiled. Many larvae exhibited symptoms associated with oil exposure in laboratory experiments and other oil spills. These included morphological malformations, genetic damage, and small size. Growth was stunted during developmental periods. Brown et al. (1996) noted the resulting 1989 year-class displayed sublethal effects in newly hatched larvae, primarily premature hatch, low weights, reduced growth, and increased morphologic and genetic abnormalities. In newly hatched larvae, developmental aberration rates were elevated at oiled sites, and in pelagic larvae genetic damage was greatest near oiled areas of southwestern Prince William Sound. Brown et al. (1996) estimated that oiled areas produced only 0.016×10^9 pelagic larvae compared with 11.82×10^9 nonoiled areas. Kocan et al. (1996) exposed Pacific herring embryos to oil-water dispersions of Prudhoe Bay crude oil in artificial seawater and found that genetic damage was the most sensitive biomarker for oil exposure, followed by physical deformities, reduced mitotic activity, lower hatch weight, and premature hatching.

Herring populations are dominated by occasional, very strong year classes that are recruited into the overall population. The 1988 prespill year-class of Pacific herring was very strong in Prince William Sound and, as a result, the estimated peak biomass of spawning adults in 1992 was very high. Despite the large spawning biomass in 1992, the population exhibited a density-dependent reduction in size of individuals, and in 1993 there was an unprecedented crash of the adult herring population. The 1989-year class was a minority of the 1993 spawning assemblage, one of the smallest cohorts observed in Prince William Sound, and it returned to spawn with an adult herring population reduced by approximately 75%, apparently because of a widespread epizootic. A viral disease and fungus may have been the immediate agents of mortality or a consequence of other stresses, such as a reduced food supply and increased competition for food.

More recently, Carls, Marty, and Hose (2002) published a synthesis of the toxicological impacts of the EVOS on Pacific herring. They compared and reinterpreted published data from industry and government sources as relating to Pacific herring in Prince William Sound that were affected by the EVOS and a 75% collapse in the adult population in 1993. They concluded that significant effects extended beyond those predicted by visual observation of oiling and by toxicity information available in 1989. Oil-induced mortality probably reduced recruitment of the 1989 year class into the fishery, but was impossible to quantify because recruitment was generally low in other Alaskan herring stocks. Significant adult mortality was not observed in 1989; biomass remained high through 1992 but declined precipitously in winter 1992-1993. The collapse was likely caused by high population size, disease, and suboptimal nutrition, but indirect links to the spill cannot be ruled out.

Information regarding impacts from the EVOS on populations of Pacific herring are relevant to this assessment, because the biological responses of herring to PAH's and oil are likely representative for other fish species (e.g., capelin and Pacific sand lance) that also inhabit the Chukchi Sea and may spawn on intertidal or nearshore substrates along the coast.

Conclusion. The studies referenced above demonstrate that when oil contaminates natal habitats, the immediate effects in one generation may combine with delayed effects in another to increase the overall impact on the affected population, thereby causing a change in distribution and/or decrease in their abundance lasting for multiple (e.g., 3 or more) generations.

The MMS reviewed the recovery status of injured fish resources tracked by the *Exxon Valdez* Oil Spill Trustee Council (Trustee Council). The Trustee Council considered recovery essentially to be "a return to conditions that would have existed had the spill not occurred" and is considered herein to equate to a return of the affected population(s) to their former status. Pacific herring, as of 2005, are not recovering; this equates to five generations since the EVOS (i.e., spring 1989). Pink salmon were listed as "not recovering"

until 1997, at which time they were regarded as “recovering.” Pink salmon were listed as “recovered” as of 2002, as were also sockeye salmon. Therefore, 6.5 generations passed since the spill before pink salmon were recovered. This information further supports the long-term effects of crude oil on herring and salmon described by Carls et al. (2005), Short et al. (2003), Peterson et al. (2003), and others noted above, as well as capturing the lingering and indirect effects of the EVOS.

IV.C.1.d(4) Large Oil-Spill from a Pipeline or a Production Platform. Section IV.A.4 and Appendix A describes the oil-spill-risk analysis used for this assessment should an oil spill occur. No large oil spills are assumed to occur during exploration activities. The spill rate of large platform and pipeline spills is 0.51 (95% confidence interval = 0.32-0.77) per billion barrels with a 40% chance (range = 27-54%) of one or more spills occurring over the life of the project (Appendix A.1, Table A.1-25 and A.1-27). For the development and production phases, the fate and behavior of a 1,500-bbl spill from a platform or a 4,600-bbl spill from a pipeline were evaluated using the SINTEF Oil Weathering Model (Appendix A). The 1,500-bbl spill would cover a smaller discontinuous area (577 km²) (Appendix A.1, Table A.1-9) than a 4,600-bbl spill (1,008 km²) (Appendix A.1, Table A.1-10) after 30 days. The OSRA uses the center of the spill mass as the contact point, so the probabilities of either spill contacting specific ERA’s would be the same. Because of this similarity, only the 4,600-bbl spill is analyzed for potential effects on fish and fishery resources.

Conditional Probabilities: This section discusses the percent chance that a large oil spill from the Sale 193 area would contact specific resource areas that are important to fish and fishery resources assuming a spill occurs.

Approximately 44% of a 4,600-bbl spill during the open water period would remain after 30 days, covering a discontinuous area of 1,008 km². A spill during broken ice in fall or under ice in winter would melt out in the following summer. Approximately 55% of a 4,600-bbl spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 332 km².

The following paragraphs present conditional probabilities (expressed as a percent chance) estimated by the OSRA model of a spill contacting fish resource areas or their habitats. Conditional probabilities are based on the assumption that a spill has occurred (Appendix A). Combined probabilities, on the other hand, factor in the chance of the spill occurring. The assessments for fishes were based on conditional probabilities. The resultant summaries recognize that models are simulations representing typical or average interactions of highly variable factors, and are used here in a broad sense in drawing conclusions about anticipated effects on fish resources.

Summer Spill. For conditional probabilities, the OSRA model estimates that a <0.5-6% chance that a large oil spill starting at launch areas (LA) 1-13 contacts land segments (LS) containing streams important to spawning chum salmon: LS 67 (Pitmegea River), LS 71 (Kukpowruk River), LS 79 (Kuk River), and LS 80 (Kugrua River) within 60 days during summer, and a <0.5-13% chance, assuming a large spill starts at Pipeline Segments (P) P1-11 (Appendix A, Table A.2-34, Maps A.1-3b, A.1-4). Pink salmon also spawn in the Kuk, Kokolik, Utukok, and Kukpowruk (among other) rivers along the Chukchi Sea coast. The greatest percent chance of contact to a chum salmon stream from a launch area occurs at LS 79 (Kuk River), which has a 6% chance of contact from a large spill occurring at LA 12. The chance of contact with this land segment is highest because the OSRA model’s launch area and the salmon stream are in close proximity to each other (Maps A.1-3b, A.1-4). The greatest percent chance of contact from a pipeline segment occurs at LS 79 (Kuk River), which has a 13% chance of contact from a large spill occurring at P13. As with the launch areas, the chance of contact with this land segment is highest, because the OSRA model’s pipeline segment and the salmon stream are in close proximity to each other (Maps A.1-3b, A.1-4).

The OSRA conditional probability analysis did not show any increases of more than 1% if the time period was extended to 360 days.

While the entrances to salmon-spawning streams are relatively easy to identify, other resource areas important to fish exist. For example, the Kasegaluk Lagoon complex (ERA 1; Map A.1-2b) includes an estuary important to rearing fish, including outmigrating salmon smolts from the Kukpowruk, Kokolik, and Utukok rivers. Also, adults appear to make use of the area as evidenced by 17 being captured there (Craig and Halderson, 1986, citing Craig and Schmidt, 1985). Other fish appear to be the attractant for large

numbers of migratory birds that make use of the area during May-October (Kinney, 1985). The OSRA estimates a 16% and a 34 % chance of a large spill contacting ERA 1 within 60 days during summer from LA 11 and P6 respectively (Table A.2-28).

On a larger scale, capelin and sand lance use beaches throughout the northeastern Chukchi Sea for spawning. Shoreline habitats are predominantly fine-to medium-grained sand beaches or mixed sand and gravel beaches between Point Hope (LS 64) and Skull Cliffs (LS 82) (Appendix A, Table A.1-8). The OSRA estimates a 44% chance that during summer a large oil spill originating at P6 or P9 would contact ERA 96 the U.S. Chukchi coast (Appendix A, Table A.2-42). A large spill during summer from offshore LA's 10-13 were estimated to have a 20-31% chance of contacting the ERA 96 (United States Chukchi Coast) within 360 days (Appendix A, Table A.2-42).

A large spill could oil an estimated 42 km of shoreline during a summer release and 51 km of shoreline as a meltout spill (winter release into/under ice) (Appendix A, Table A.1-9). The OSRA trajectory model predicts movement of a surface slick, but does not assess subsurface transport of oil in water or tarballs onto beaches or the persistence of oil once it has been transported to spawning beaches, rearing areas, or spawning streams.

Finally, as the Chukchi Sea Sale 193 area is adjacent to the Beaufort Sea, the potential for a large spill originating in the Chukchi Sea contacting the Beaufort Sea coast was estimated. A large spill during summer from offshore LA's 13 or 8 was estimated to have a 19-20% chance of contacting the ERA 97 (United States Beaufort Coast) within 360 days (Appendix A, Table A.2-42). Similarly, the OSRA trajectory model predicted that a large spill originating in the Chukchi Sea lease sale area had <0.5% chance of contacting the Beaufort Sea shoreline east of LS 92 (near Cape Halkett, ~50 mi west of the Colville River Delta) (Appendix A, Table A.2-36; Maps A.1-3c, A.1-4).

Winter Spill. For conditional probabilities, the OSRA model estimates a <0.5-2% chance that a large oil spill starting at LA's 1-13 will contact land segments containing streams important to spawning chum salmon: LS 67 (Pitmegea River), LS 71 (Kukpowruk River), LS 79 (Kuk River), and LS 80 (Kugrua River) within 60 days during winter, and a <0.5-6% chance, assuming a spill starts at P1-P11 (Appendix A, Table A.2-58; Maps A.1-4, A.1-3b). The greatest percent chance of contact from a launch area occurs at LS 73 (part of Kasegaluk Lagoon), which has a 4% chance of contact from a large spill occurring at LA 10 within 60 days (Appendix A, Table A.2-58). The chance of contact in this LS is highest, because the OSRA model's launch area and the land segment are in close proximity to each other (Maps A.1-3b, A.1-4). The greatest percent chance of contact from a large spill originating at a pipeline segment occurs at LS 73 (part of Kasegaluk Lagoon), which has an 8% chance of contact from a spill occurring at P6 (Appendix A, Table A.2-58). As with the launch areas, the chance of contact with this land segment is highest because the OSRA model's pipeline segment and the land segment are in close proximity to each other (Maps A.1-3b, A.1-4).

The OSRA conditional probability analysis did not show any increases of more than 5% if the time period was extended to 360 days.

A large spill during the winter from offshore LA's 8 or 13 was estimated to have a 9-10% chance of contacting ERA 97 (United States Beaufort Coast) within 360 days (Appendix A, Table A.2-66). Similarly, the OSRA trajectory model estimated that a large spill originating from any launch area in the Chukchi Sea lease sale area had a <0.5% chance of contact with the Beaufort Sea shoreline east of LS 88 (east of Smith Bay) (Appendix A, Table A.2-60; Maps A.1-3c, A.1-4).

There are numerous instances and probabilities whereby oil may contaminate intertidal/estuarine substrates and waters that may be used as spawning and/or rearing habitat to either pink salmon or capelin populations. The PAH's in weathered oil contaminating such spawning sites are expected to be biologically available for long periods and very toxic to sensitive lifestages. Lethal effects, or sublethal effects reducing reproductive fitness or survival, of rare and/or highly aggregated species (e.g., capelin, pink salmon), may be more consequential to their respective populations via Allee effects. The Allee effect is a phenomenon in biology used to describe the positive relation between population density and the per capita growth rate. In other words, for smaller populations, the reproduction and survival of individuals decreases. The result is that fewer juvenile pink and chum salmon or capelin would survive, so that

recruitment from the early lifestages is reduced and adult populations may not be replaced at sustainable levels for more than three generations because adult populations may gradually decline to unsustainable numbers.

IV.C.1.d(5) Chronic Small-Volume Spills. Small volumes of oil may be released from leaking tanks and valves, accidents during loading and offloading, and flushing of tanks and bilges. Small or low-volume spills are defined as <1,000 bbl. The average crude-oil spill size is 126 gal (3 bbl). An estimated 178 small crude oil spills would occur during the 25-year oil-production period (Appendix A, Table A.1-29), an average of over 7 per year. The average refined-oil spill size is 29 gal (0.7 bbl) and an estimated 440 refined-oil spills would occur during the 25-year oil-production period (Appendix A, Table A.1-32), an average of 17.6 per year. Overall, an estimated 25 small-volume crude and refined oil spills would occur each year of production. It is unknown how many small-volume spills or what total volume would reach areas used by fish in the nearshore coastal areas. These spills would be subject to the same environmental factors that influence the trajectory analysis (currents, wind patterns, etc.). The trajectory analysis indicates that about one spill every 2 years could reach nearshore coastal areas. If these small-volume spills occurred during beach spawning events or incrementally harmed resident fish on a recurrent basis, reproduction for certain species could be reduced. If these spills were to repeatedly reach fish in sensitive lifestages, depression of recruitment, over time, could result in the elimination of specific population segments, including salmon runs (Fig. IV.C-1).

While small-spills are required to be reported, the number of unreported spills is unknown. Not all spills would be expected to receive a spill-response. Overall, it is unclear whether, over the long-term and in the absence of a monitoring program to assess effects, any negative impacts to fish resources from chronic small spills would be detected.

IV.C.1.d(6) Effects from a Spill during Seismic Activities.

The MMS assumes that marine resources could be exposed to accidentally spilled lubricating oil or diesel fuel from a vessel associated with seismic-survey operations or by a leaking or torn streamer array under tow by a vessel. Some streamers are filled with liquid paraffin to provide buoyancy that, if released, is biodegradable and evaporates very quickly. Newer streamers are filled with foam. The impacts on fish and fishery resources from streamer array spills are regarded as negligible.

The MMS believes that the incidents involving the release of oil and fuel from seismic survey vessels during refueling would likely be on the order of <5 gal per refueling event; in total, approximately 20 gal of fuel might be spilled per year during the seismic-survey season. Refueling operations in the Chukchi Sea likely would occur at sea with the use of fuel-supply vessels. Accidental spills associated with refueling operations are not likely to occur in the same location at the same time. Each accidental spill of 5 gal or less likely would impact local areas and adversely affect relatively few fish. Such small spills are ephemeral events. An accidental spill offshore would likely be of low impact relative to a spill in coastal waters that serve as important spawning, nursery, and feeding areas. The periodic accidental spills of approximately 5 gal during refueling operations is not believed likely to result in an adverse impact to fish resources in the Chukchi Sea.

IV.C.1.d(7) Effects from Oil-Spill Response. Conditional probabilities do not factor in the effectiveness of oil spill response activities to large spills, which range from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. An Oil Spill Response Plan would be required prior to oil production.

Oil spill response could originate from Deadhorse, about 150 mi east of Barrow. Specific resource protection activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with state officials on fishery management issues in the event of a spill, including the need, for example, to boom the entrances to salmon spawning streams. Effectiveness could, however, be expected to improve if spill response equipment were staged closer to the site of a potential spill (see Sec. IV.C.1.d(5)).

IV.C.1.d(8) Mitigation Measures.

IV.C.1.d(8)(a) Standard Mitigation Measures Considered in this Analysis. The effects on fish resources could be moderated slightly by two lease stipulations, Information to Lessees (ITL's) and mitigation measures.

Stipulation No. 1, Protection of Biological Resources, lowers the potential adverse effects to unique biological communities that may be important to rare fish species identified during oil exploration or development activities and provides additional protection.

Stipulation No. 3, Transportation of Hydrocarbons, is described Section II.B.3.c(1). Nearshore resources such as fish near river deltas probably would benefit the most from it. The U.S. spill rate from pipelines is lower than the rate from barges, and this stipulation requires pipeline when feasible. Specifically, 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.

Mitigation for fish resources includes ITL No. 3, Information to Lessees on River Deltas, which advises lessees that certain river deltas of the Chukchi Sea coastal plain have been identified as special habitats for fish. Shore-based facilities in these river deltas may be prohibited by the permitting agency. The ITL No. 8, Sensitive Areas to be Considered in Oil Spill Response Plan, advises lessees that certain areas are especially valuable for their concentrations of fishes and other biota and should be considered when developing oil spill response plans (OSRP's). Identified areas and time periods of special biological sensitivity include streams containing populations of salmon: Pitmegea, Kukpowruk, Kuk, Kokolik, Utukok, and Kugrua rivers, January-December. These areas are to be considered in the OSRP required by 30 CFR 254.

Section II.B.4.a includes mitigation measures for seismic operations in the Chukchi Sea. These include:

3. Operators must maintain a minimum spacing of 15 miles (25 km) between the seismic-source vessels for separate simultaneous operations.
4. Ramp Up - This technique involves the gradual increase (usually 5-6 dB per 5-minute increment) in emitted sound levels, beginning with firing a single airgun operating level of the full array is obtained. Ramping up airgun emissions could provide fish an opportunity to move away from the noise source, thereby reducing the risk of injury or altered behavior to negligible levels.

IV.C.1.d(8)(b) Mitigation Measures Proposed but not Considered in this Analysis. The following mitigation measures are recommended but were not considered during our analysis.

Exploration Activities:

- Monitor noise levels for drilling activities located within 30 km of shore.
- Prestage oil spill response equipment along Chukchi Coast.

Construction Activities:

- Prestage oil spill response equipment along the Chukchi coast.
- Construct and maintain facilities during winter.
- Identify high-value fish habitats, implement avoidance criteria.
- Implement effective sediment and erosion control.

IV.C.1.d(9) Conclusion.

IV.C.1.d(9)(a) Anticipated Impacts from the Proposed Action on Fish Resources.

Effects from Seismic Surveys. A review of the available science and management literature shows that at present, there are no empirical data to document potential impacts from seismic surveys reaching a local population-level effect. The experiments conducted to date have not contained adequate controls to allow us to predict the nature of a change or that any change would occur. Thus, the information that does exist has not demonstrated that seismic surveys alone would result in significant impacts to marine fish or related issues (e.g., impacts to migration/spawning, rare species, subsistence fishing).

Periodic accidental spills of approximately 5 gal during refueling operations during seismic surveys or potential rupturing of seismic streamers is not believed likely to result in an adverse impact to fish resources in the Chukchi Sea.

Effects from Exploration Drilling. Scientific evidence suggests that some species of fish may be displaced from or choose not to enter areas of intense underwater noise. In contrast to seismic surveys, in which the source vessel has an associated zone of noise influence that moves with it through an area, exploratory drilling places a noise source in one area for 30-90 days (or more), creating a potential stationary zone of displacement around the well site(s). If this zone were close to shore, a migration barrier or zone of displacement within important rearing habitats could develop. Negative effects are species specific and could affect one age-class cohort per year. Potential lease blocks in the proposed lease-sale area are as close as 10 mi from shore, with most lease blocks much farther, particularly those blocks offshore of salmon streams. Some salmon streams are protected by offshore barrier islands. Consequently, it is not likely that exploration drilling activities would result in adverse effects to fish populations that would take three or more generations to recover.

Effects from Production. Noise-related disturbance effects to fish and direct loss or degradation of fish habitats would likely occur during construction in the marine environment (e.g., well sites, platform placement, pipeline trenching/burial) and at freshwater sites (pipeline and maintenance road construction). Future facility locations would be evaluated on a site-specific basis to avoid or minimize adverse construction-related impacts to fish habitats that could be affected by the proposed lease sale. These construction activities are anticipated to result in temporary and/or localized adverse impacts to fish and fish habitats, but recovery would be expected to occur in fewer than three generations.

A large oil spill impacting intertidal or estuarine spawning and rearing habitats used by capelin or other fishes potentially could result in significant adverse impacts to some local breeding populations. Recovery to former status by dispersal from nearby population segments would require more than three generations. Given a lack of contemporary abundance and distribution information, large oil spill effects on rare or unique species (including potential extirpation) could occur, but would likely go unnoticed or undetected.

Depending on the timing, extent, and persistence of a large spill, some distinct runs of pink and chum salmon could be eliminated. Recovery from this significant adverse impact would only occur as strays from other populations colonized the streams after the oiled habitats recovered. These local fish stocks would not be available for subsistence harvest for many years.

Chronic small-volume spills reaching intertidal or estuarine spawning and rearing habitats used by capelin, salmon, or other fishes potentially could periodically impact local stocks that could decrease the numbers of breeding adults and/or suppress recruitment requiring less than 3 generations to recover to their former status. Chronic degradation of salmon habitats could lead to the gradual loss of distinct stocks. Recovery would not occur if degraded conditions persisted.

For the purposes of evaluating the potential impacts of a large oil spill on fish resources, oil spill response is assumed to have limited effectiveness (less than 100% of spilled oil recovered) because of the unpredictability of response time, proximity of the launch site(s) to fish concentration areas, known limitations of response during certain environmental conditions (such as under ice or broken-ice), and the numbers of fish that could be impacted in a short period of time (less than [$<$] 36 hours).

IV.C.1.e. Essential Fish Habitat

Large coastal and marine portions of the proposed Chukchi Sea sale area have been described as essential fish habitat (EFH) for five species of Pacific salmon (chinook, coho, sockeye, chum, and pink) occurring in Alaska. Salmon EFH also includes all freshwater streams, lakes, ponds, wetlands, and other waterbodies currently or historically accessible to salmon. Marine EFH is described in Section III.B.3.

IV.C.1.e(1) Summary.

IV.C.1.e(1)(a) Seismic Surveys. Seismic surveys conducted in association with the proposed lease sale would have minor adverse impacts on EFH.

IV.C.1.e(1)(b) Exploration and Production. Future facility locations would be evaluated on a site-specific basis to avoid or minimize adverse construction-related impacts to EFH that could be affected by the proposed lease sale. Specific regulatory processes and required consultations would guide mitigation efforts to reduce direct construction impacts to fish-bearing streams and lakes such as clear-span crossings, setbacks, and sediment- and erosion-control measures. Construction-related impacts would result in minor adverse impacts to freshwater and marine salmon EFH.

In the event of a large oil spill or chronic small-volume spills, effects on Pacific salmon EFH would depend primarily on the season and location of the spill; the lifestage of the fishes (adult, juvenile, larval, or egg) impacted; and the duration of the exposure. A large oil spill or chronic small-volume spills impacting intertidal or estuarine spawning, rearing, and migration habitats used by early life-history stages of Pacific salmon are likely to result in significant adverse effects on local populations requiring three or more generations to recover to their former status. Impacts to these fish habitats could result in loss of discrete population stocks. These salmon stocks would only recover only by colonization by strays from nonaffected populations.

IV.C.1.e(2) Potential Effects from 3D Seismic Surveys on Essential Fish Habitat Airgun emissions from seismic surveys conducted in the Chukchi Sea sale area may ensonify and adversely affect Pacific salmon EFH. Seismic airgun emissions also extend into infrasound (sound below 20 Hz) levels (as low as 10 Hz; see Sec. IV.A.2.b(1)). Juvenile salmonids display strong avoidance reactions to infrasound, and infrasound has been used as an effective acoustic barrier for downstream migrating Atlantic salmon (*Salmo salar*) smolts. Therefore, airgun emissions may act to deflect and displace Pacific salmon fry from nursery habitat in coastal waters of the lease sale area, or to herd salmon around in offshore waters. Deflection and displacement from suitable nursery and foraging habitat may adversely affect the survival of juvenile Pacific salmon and their recruitment to a breeding cohort. Adverse impacts such as displacement of Pacific salmon fry from nursery habitat areas in coastal waters of the lease sale area may make them more vulnerable to predation by other fishes occurring in higher concentrations as a result of displacement from their preferred habitat. Because these potential effects are localized and are temporary, only minor adverse effects would be expected to occur to marine salmon EFH.

IV.C.1.e(3) Potential Effects from Exploration and Development on Essential Fish Habitat.

Platform and Pipeline Construction. Exploration and production wells and a production platform footprint would result in a direct loss of seafloor habitats at the placement site, but these sites are relatively small compared to the amount of similar habitats available to salmon in the marine environment.

Trenching and pipelaying would take place during the short open-water season or during mid- to late winter, when landfast ice has stabilized. Offshore pipelines would be trenched as a protective measure against damage by ice in all water depths <165 ft (50 m). This trenching would create turbidity around the trenching site that, depending on the nature of the substrate, remains suspended for short amounts of time or be moved offsite into other areas. At a coastal landfall, the pipeline likely would be elevated on a short gravel causeway protect it against shoreline erosion. The specific locations of these facilities are unknown, but would be evaluated under a subsequent NEPA document and EFH consultation in an effort to minimize any adverse habitat loss or degradation.

Furthermore, as described in Section I.E (Postlease Process), regulatory processes and jurisdictional authority concerning pipelines on the OCS and in coastal areas are shared by several Federal Agencies.

Pipeline permit applications to MMS include the pipeline location drawing, profile drawing, etc. The MMS evaluates the design and fabrication of the pipeline and prepares a NEPA document in accordance with applicable policies and guidelines. The MMS prepares an EA and/or an EIS on all pipeline right-of-ways that go ashore. The FWS reviews and provides comments on applications for pipelines that are near certain sensitive biological communities. No pipeline route will be approved by MMS if any bottom-disturbing activities (from the pipeline itself or from the anchors of lay barges and support vessels) encroach on any biologically sensitive areas, such as stipulation-established No Activity Zones.

Post-landfall pipeline and associated maintenance road alignment would depend on a number of factors, including cost and distance and avoidance of wetlands and other sensitive bird and wildlife habitats as dictated by Federal policy and law. These policies would guide mitigation efforts to reduce direct construction impacts to fish-bearing streams and lakes such as clear-span crossings, setbacks, and sediment- and erosion-control measures.

Future facility locations would be evaluated on a site-specific basis to avoid or minimize adverse construction-related impacts to fish habitats that could be affected by the proposed lease sale.

IV.C.1.e(4) Potential Effects of a Large Oil Spill on Essential Fish Habitat. There are various aspects of important fish habitats that make them vulnerable to potential effects of a large oil spill. Young salmon use estuaries and shallow coastal waters as rearing and feeding grounds and migration areas (Costello, Elliott, and Thiel, 2002; Elliott, 2002, citing McHugh 1967, Haedrich, 1983). Juvenile salmon EFH within the intertidal, estuarine, and nearshore zone in the Chukchi Sea would be among the areas considered more vulnerable to effects from oil-related activities. The different ways that hydrocarbons can affect juvenile salmon are detailed in Section IV.C.1.d(3)(d).

The following analysis discusses the chance that a large oil spill from the proposed Chukchi Sea lease sale area would contact areas containing EFH assuming a large spill occurs. No large oil spills are assumed to occur during exploration activities. The spill rate of large platform and pipeline spills is 0.51 (95% confidence interval (CI) = 0.32-0.77) per billion barrel with a 40% chance (range = 27-54%) of one or more large spills occurring over the life of the project (Appendix A.1, Table A.1-25).

For the development and production phases, the fate and behavior of a 1,500-bbl spill from a platform and a 4,600-bbl spill from a pipeline were evaluated using the SINTEF Oil Weathering Model (Appendix A). The 1,500-bbl spill would cover a smaller discontinuous area (577 km²) (Appendix A.1, Table A.1-9) than a 4,600-bbl spill (1,008 km²) (Appendix A.1, Table A.1-10) after 30 days. The OSRA uses the center of the spill mass as the contact point, so the probabilities of either spill contacting specific ERA's would be the same. Because of this similarity, only the 4,600-bbl spill is analyzed for potential effects on EFH.

Approximately 44% of a 4,600-bbl spill during the open-water period would remain after 30 days, covering a discontinuous area of 1,008 km². A spill during broken ice in the fall or under ice in the winter would melt out in the following summer. Approximately 55% of a 4,600-bbl spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 332 km².

IV.C.1.e(4)(a) Conditional Probabilities. This section discusses the percent chance that a large oil spill from the Sale 193 area would contact specific ERA's that are important to fish and fishery resources. Because it is difficult to separate potential impacts to fish habitats to the fish using them, much of this information was previously described under Section IV.C.1.d(3)(d).

The following paragraphs present conditional probabilities (expressed as a percent chance) estimated by the OSRA model of a spill contacting specific ERA or shoreline areas (representing nearshore fish habitats). Conditional probabilities are based on the assumption that a spill has occurred (Appendix A). Combined probabilities, on the other hand, factor in the chance of the spill occurring. The assessments for fishes were based on conditional probabilities. The resultant summaries recognize that models are simulations representing typical or average interactions of highly variable factors, and are used here in a broad sense in drawing conclusions about anticipated effects on fish resources.

IV.C.1.e(4)(b) Summer Spill. For conditional probabilities, the OSRA model estimates that a <0.5-6% chance that a large oil spill starting at LA 1-13 contacts land segments containing streams important to

spawning chum salmon: LS 67 (Pitmegea River), LS 71 (Kukpowruk River), LS 79 (Kuk River), and LS 80 (Kugrua River) within 60 days during summer and a <0.5-13% chance, assuming a large spill starts at P1-P11 (Appendix A, Table A.2-34, Maps A.1-3b, A.1-4). Pink salmon also spawn in the Kuk, Kokolik, Utukok, and Kukpowruk (among other) rivers along the Chukchi Sea coast. The highest percent chance of contact to a chum salmon stream occurs at LS 79 (Kuk River), which has a 6% chance of contact from a large spill occurring at LA 12. The chance of contact to this land segment is highest, because the OSRA model's launch area and the salmon stream are in close proximity to each other (Maps A.1-3b, A.1-4). For pipelines, the highest percent chance of contact occurs to LS 79 (Kuk River), which has a 13% chance of contact from a large spill occurring at P13. As with the launch areas, the chance of contact to this land segment is highest, because the OSRA model's pipeline segment and the salmon stream are in close proximity to each other (Maps A.1-3b, A.1-4).

The OSRA conditional probability analysis did not show any increases of more than 1% if the time period was extended to 360 days.

While the entrances to salmon-spawning streams are relatively easy to identify, other resource areas important to fish exist. For example, the Kasegaluk Lagoon complex (ERA 1; Map A.1-2b) includes an estuary important to rearing fish, including outmigrating salmon smolts from the Kukpowruk, Kokolik, and Utukok rivers. Also, adults appear to make use of the area as evidenced by 17 being captured there (Craig and Halderson, 1986, citing Craig and Schmidt, 1985). The OSRA estimates a 16% and a 34% chance of a large spill contacting ERA 1 within 60 days during summer from LA 11 and P6, respectively (Appendix A, Table A.2-28).

On a larger scale, juvenile salmon migrate along nearshore areas of the northeastern Chukchi Sea. The OSRA model estimates a 44% chance that during the summer a large oil spill originating at P6 or P9 would contact the ERA 96 (United States Chukchi Coast) (Map A.1-3d, Appendix A, Table A.2-42), passing through these migration habitats. A large spill during the summer from offshore LA's 10-13 were estimated to have a 20-31% chance of contacting the shoreline within 360 days (Appendix A, Table A.2-42).

A large spill could oil an estimated 42 km of shoreline during a summer release and 51 km of shoreline as a meltout spill (winter release into/under ice) (Appendix A, Table A.1-9). The OSRA trajectory model predicts movement of a surface slick, but does not assess subsurface transport of oil in water or tarballs onto beaches or the persistence of oil once it has been transported to rearing and migration areas.

Finally, as the Chukchi Sea sale area is adjacent to the Beaufort Sea, the potential for a large spill originating in the Chukchi Sea contacting the Beaufort Sea coast was evaluated. A large spill during summer from offshore LA's 13 or 8 was estimated to have a 19-20% chance of contacting the ERA 97 (U.S. Beaufort Sea shoreline) within 360 days (Appendix A, Table A.2-42). Similarly, the OSRA model estimates that a large spill originating in the Chukchi Sea lease sale area has a <0.5% chance of contacting the Beaufort Sea land segments east of LS 92 (near Cape Halkett, ~50 mi west of the Colville River Delta) (Appendix A, Table A.2-36; Maps A.1-3c, A.1-4).

IV.C.1.e(4)(c) Winter Spill. For conditional probabilities, the OSRA model estimates a <0.5-2% chance that a large oil spill starting at LA's 1-13 will contact land segments containing streams important to spawning chum salmon: LS 67 (Pitmegea River), LS 71 (Kukpowruk River), LS 79 (Kuk River), and LS 80 (Kugrua River) within 60 days during winter and a <0.5- 6%, assuming a large spill starts at P1-P11 (Appendix A, Table A.2-58; Maps A.1-4, A.1-3b). The highest percent chance of contact from a launch area occurs to LS 73 (part of Kasegaluk Lagoon), which has a 4% chance of contact from a large spill occurring at LA 10. The chance of contact in this ERA is highest, because the OSRA model's launch area and the land segment are in close proximity to each other (Maps A.1-3b, A.1-4). The greatest percent chance of contact from a large spill originating at a pipeline segment occurs to LS 73 (part of Kasegaluk Lagoon), which has an 8% chance of contact from a spill occurring at P6 (Appendix A, Table A.2-58). As with the launch areas, the chance of contact to this land segment is highest, because the OSRA model's pipeline segment and the land segment are in close proximity to each other (Maps A.1-3b, A.1-4).

The OSRA conditional probability analysis did not show any increases of more than 5% if the time period was extended to 360 days.

A large spill during winter from offshore LA's 8 or 13 was estimated to have a 9-10% chance of contacting the ERA 97 (U.S. Beaufort Sea shoreline) within 360 days (Appendix A, Table A.2-66). Similarly, the OSRA model estimates that a spill originating in the Chukchi Sea lease sale area had a <0.5% chance of contact with the Beaufort Sea land segments east of LS 88 (east of Smith Bay) (Appendix A, Table A.2-60; Maps A.1-3c, A.1-4).

IV.C.1.e(4)(d) Potential Effects of Chronic Small-Volume Spills. Small volumes of oil may be released from leaking tanks and valves, accidents during loading and offloading, and flushing of tanks and bilges.

For the proposed lease sale, small-volume spills are defined as being <1,000 bbl. The average crude oil-spill size is 126 gal (3 bbl). An estimated 178 small crude oil spills would occur during the 25-year oil production period (Appendix A, page A.1-26; Table A.1-29), an average of more than 7 per year. The average refined-oil spill size is 29 gal (0.7 bbl), and an estimated 440 refined oil spills would occur during the 25-year oil production period (Appendix A, page A.1-26; Table A.1-32), an average of 17.6 per year. Overall, an estimated 25 small-volume oil spills would occur each year of production.

It is unknown how many small-volume spills or what total volume would reach fish habitats. Trajectory analysis indicates that, on average, two small spills could reach nearshore salmon EFH every 4 years. If these small-volume spills were in close proximity to habitats important to sensitive lifestages of salmon, lethal and sublethal effects could lead to decreasing fecundity, and productivity of local salmon runs would be expected to occur.

IV.C.1.e(5) Potential Effects from Oil-Spill Response. Conditional probabilities do not factor in the effectiveness of oil-spill-response activities to large spills, which range from highly effective under ideal conditions to largely ineffective during unfavorable or broken-ice conditions. An OSRP would be required prior to oil production.

Oil-spill response could originate from Deadhorse, about 150 mi east of Barrow. Specific resource-protection activities would be employed as the situation requires and would be modified as needed to meet the current needs. The response contractor would be expected to work with State officials on fishery management issues in the event of a spill, including the need, for example, to boom the entrances to salmon-spawning streams.

Oil-spill response is assumed to have limited effectiveness (less than 100% of spilled oil recovered) because of the unpredictability of response time, proximity of the launch site(s) to salmon EFH, known limitations of effectiveness of response during certain environmental conditions (such as under ice or broken ice), and the numbers of fish that could be impacted in a short period of time (less than [<] 36 hours).

IV.B.1.e(6) Mitigation Measures.

Mitigation Measures Considered in this Analysis. The effects on EFH would be moderated slightly by two lease stipulations and Information to Lessees (ITL's).

Stipulation No. 1, Protection of Biological Resources, lowers the potential adverse effects to unique biological communities that could be important to rare fish species identified during oil exploration or development activities and provides additional protection.

Stipulation No. 3, Transportation of Hydrocarbons, is described in Section II.B.3c(1). Nearshore resources such as fish habitats near river deltas probably would benefit the most from it. The U.S. spill rate from pipelines is lower than the rate from barges, and this stipulation requires pipeline when feasible. Specifically, 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.

Mitigation for essential fish habitat also includes ITL No. 3, Information to Lessees on River Deltas, which advises lessees that certain river deltas of the Chukchi Sea coastal plain have been identified as special habitats for fish. Shore-based facilities in these river deltas may be prohibited by the permitting agency. The ITL No. 8, Sensitive Areas to be Considered in Oil Spill Response Plans, advises lessees that certain areas are especially valuable for their concentrations of fishes and other biota and should be considered when developing an OSRP. Identified areas and time periods of special biological sensitivity include streams containing populations of salmon: Pitmegea, Kukpowruk, Kuk, and Kugrua rivers, May-October; kelp beds near Peard Bay/Skull Cliffs and 25 km southwest of Wainwright, January-December. These areas are among areas of special biological sensitivity to be considered in the OSRP required by 30 CFR 254.

Mitigation Measures Recommended but not Considered in this Analysis. Additional mitigation measures can help avoid or limit the potential for adverse impacts to EFH beyond standard mitigation measures identified above. The following mitigation measures are specifically designed to limit potential impacts to EFH. These are presently not included in any of the alternatives.

Exploration and Production Activities:

- Monitor noise levels for drilling activities within 30 km of shore.
- Prestage oil spill response equipment along Chukchi Coast.
- Construct and maintain facilities during winter.
- Identify high-value fish habitats, implement avoidance criteria.
- Implement effective sediment and erosion control.

IV.B.1.e(7) Anticipated Impacts from the Proposed Action on Essential Fish Habitat

Effects of Seismic Surveys. Seismic surveys conducted in association with the proposed lease sale would have minor adverse impacts on EFH.

Effects of Exploration Scientific evidence suggests that some species of fish may be displaced from or choose not to enter areas of intense underwater noise. In contrast to seismic surveys, in which the source vessel has an associated zone of noise influence that moves with it through an area, exploratory drilling places a noise source in one area for 30-90 days (or more), creating a potential stationary zone of displacement around the well site(s). If this zone was close to shore, a migration barrier or zone of displacement within important rearing habitats could develop. Negative effects are species-specific and could affect one age-class cohort per year. Potential lease blocks in the Proposed Lease Sale area are as close as 10 mi from shore, with most lease blocks much further, particularly those blocks offshore of salmon streams. Some salmon streams are protected by offshore barrier islands. Consequently, it is not likely that exploration drilling activities would result in adverse effects to EFH.

Effects of Development.

Construction-Related Impacts. Future facility locations would be evaluated on a site-specific basis to avoid or minimize adverse construction-related impacts (noise, disturbance, habitat loss, etc.) to fish habitats that could be affected by the proposed lease sale. Specific regulatory processes and required consultations would guide mitigation efforts to reduce direct construction impacts to fish-bearing streams and lakes such as clear-span crossings, setbacks, and sediment- and erosion-control measures. Construction-related impacts are determined to result in minor adverse impacts to freshwater and marine salmon EFH. Implementation of additional mitigation measures further could reduce construction-related impacts to EFH.

Oil-Spill Impacts. There are numerous instances and probabilities whereby oil may contaminate intertidal or estuarine substrates and waters that may be used as salmon spawning, rearing, and migration habitats. The PAH's in weathered oil contaminating such spawning sites are expected to be biologically available for long periods and very toxic to sensitive lifestages. Lethal effects, or sublethal effects reducing reproductive fitness or survival of highly aggregated species (e.g., capelin, sand lance), may be more consequential to their respective populations. Impact recovery to these species could occur by emigration from surrounding

subpopulations once contaminated habitats have recovered. Overall, recovery could take more than three generations to occur.

If an entire young-of-the-year cohort of a salmon run is killed, a local salmon run could be eliminated. If recruitment from the early lifestages of salmon runs is only reduced, adult populations may not be replaced at sustainable levels for more than three generations, and discrete stocks may gradually decline to extinction. Recovery of these salmon runs would occur only by colonization by strays from other nearby unaffected populations.

Conclusion. A large oil spill or chronic small-volume spills impacting intertidal or estuarine spawning, rearing, and migration habitats used by early life-history stages of Pacific salmon is likely to result in significant adverse effects on local populations requiring three or more generations to recover to their former status. Impacts to these fish habitats could result in loss of discrete population stocks. These salmon stocks would recover only by colonization by strays from nonaffected populations.

IV.C.1.f. Threatened and Endangered Species.

IV.C.1.f(1) Threatened and Endangered Marine Mammals.

Introduction. The analyses in this section are based on the exploration, development, production, and abandonment scenarios presented in Section IV.A and evaluates whether reasonably foreseeable oil and gas activities in the Chukchi Sea Planning Area could potentially have adverse effects on endangered bowhead, fin, and humpback whales.

The section begins by identifying the general ecological principles and assumptions underlying the analyses. Explicitly stated are specific assumptions about the Proposed Action and the potentially affected species underlying the analyses. Potential pathways by which endangered cetaceans may or may not potentially be affected by different pre- and postlease oil and gas activities (i.e., associated with the exploration, development, production, and abandonment scenario) in the Chukchi Sea Proposed Action area are identified and environmentally assessed. If a species potentially could be affected, a more in-depth evaluation of potential effects is provided; if not affected, only a brief summary is provided.

Because exploration, development, and production could, in future years, occur simultaneously, our discussion groups potential pathways of impact by those that have common modes of potential impact (e.g., activities that cause noise and disturbance). Background information necessary to understand the way(s) in which the general class of affecter (e.g., marine noise) could cause impacts to endangered whales is initially presented, followed by a review of specific information about the type of affecter (e.g., drilling noise) that potentially could cause impact and how the potentially exposed species might be impacted. Areas and times when potential effects might reasonably be expected to be greater than typical are identified. Lastly, a summary of potential effects and conclusions by species is provided.

It is important to note that the level of uncertainty about the potential effects on threatened and endangered whales within the Proposed Action area increases the further out in time we attempt to predict activities, especially those activities that may occur beyond 2007. Because of the uncertainty about future potential activities, our analyses are more likely to err on the side of being more environmentally conservative (i.e., protective). For example, assumptions about activity levels, based on historical patterns, may be overestimates; therefore, potential effects may be overestimated and mitigating measures put into place to reduce such potential effects would be precautionary. If our assumptions prove to be underestimates such that the activities could result in effects to listed species of a kind or to an extent that was not covered in this consultation, ESA Section 7 consultation with NMFS would be reinitiated prior to taking actions that could result in such unanticipated effects.

In anticipation of potential new leasing in the Chukchi Sea, the MMS Environmental Studies Program has several Chukchi Sea studies ongoing or being procured. These are listed at http://www.mms.gov/alaska/ess/ESS_ONG.pdf.

IV.C.1.f(1)(a) Principles and Assumptions Underlying Analyses of Potential Effects.

Potential Effects on females with calves, on newborn calves, on all calves over their first year, and on females, merit special consideration. Baleen whales are a relatively long-lived, late maturing group of species with relatively low reproductive rates, and with extremely high maternal investment in young. A major hypothesis of life-history theory is that future survival and reproductive success are affected by early development conditions (Beauplet et al., 2005). The probability of postweaning survival to age 1 increases with body condition in at least some marine mammals (Hall, McConnell, and Barker, 2001). In a species such as the bowhead whale, where the periods of body growth, maturation, gestation, maternal care, and intervals between reproductive attempts are all (mostly relatedly) long, the ability of the female to provide adequate care (through nursing and possibly the teaching of the locations of key resources) to her offspring during its period of dependency is critical to the continued recovery and the long-term viability of the population. In providing guidance on the evaluation of whether ocean noise disturbance of marine mammals should be considered biologically significant, the NRC (2005:82-83:Box 4-1) stated that:

Different standards for disruption of breeding behavior should be considered for females and males. The ability of a female to select a mate, breed, gestate, and give birth to a viable offspring is so essential to populations that there should be very low tolerance of disturbances that might affect these activities....

Very low thresholds should be considered for any disturbance that might separate a dependent infant from its caregivers...Both the duration of nursing bouts and the distribution of intervals might be important....

The effects of anthropogenic noise and other potential affecters (e.g., oil spills) on baleen (or other cetacean) calves, especially newborn calves, is highly uncertain. Absent direct information on potential effects on baleen calves, we draw on more general mammalian literature about potential effects on very young individuals. Data from other mammalian species, such as humans, indicates that there are deleterious effects on offspring and juvenile hearing and health due to exposure to excessive noise during pregnancy; infancy (Committee on Environmental Health, 1997; Chang and Merzenich, 2003); and even childhood. "Developing mammals are more sensitive to noise...than adults" (Henley and Rybak, 1995). "Children and unborn children are in certain respects especially vulnerable to environmental effects..." of noise. "It is not only the dose that is important in determining whether harm will arise but also the development stage when the exposure occurs. Organ systems that develop and mature over a long period are considered to be particularly vulnerable. Examples of such organ systems are the brain, the hormone system, the reproductive organs and the immune system," (K. Victorin, available at <http://www.env.go.jp/en/topic/health03/01.pdf>). This information also supports special concern and mitigation aimed at reducing impacts to these age classes of whales. When this information is considered in concert with data indicating potential extreme longevity of bowheads and the potential for repeated exposures throughout a whale's life to seismic and other noise (see below), or to repeated pollution events, this concern is heightened.

Available data also indicate that female mammals with young (Bergerud, 1974), including female baleen whales (McCauley et al., 2000), show a heightened response to noise and disturbance, including seismic noise than do juvenile and adult males. McCauley et al. (2000) summarized that in their experience, humpback whale cow/calf pairs are more likely to exhibit an avoidance response to a sound to which they are unaccustomed. They recommended that "...any management issues related to seismic surveys should consider the cow/calf responses as the defining limits" (McCauley et al., 2000:697). They also recommended that management decisions distinguish between whales that are in a "...key habitat type" (McCauley et al., 2000:698) and those that are migrating through an area. They list areas used for feeding, resting, socializing, mating, calving, or other key purposes as "key habitats."

Thus, for reasons provided in the above paragraphs, potential effects on females and on calves are emphasized in our analyses, and mitigation measures are identified to avoid and/or minimize these impacts.

Potential effects of "key habitat types" such as those used for calving, feeding, breeding, and resting; and those portions of the migratory pathway where the movements of the whales are constrained (e.g., the spring lead and polynya systems used by bowhead whales) merit special consideration. Whales do not use all portions of their range in a random fashion. Thus, impacts in all portions of the range

are not of equal importance. To the extent that information exists, we have highlighted potential effects that could affect the use of areas used for calving, feeding, resting, and breeding by large numbers of whales. We have also highlighted potential effects on areas of the migratory pathway where the whale movements are constrained.

The considerable potential longevity of the bowhead whale, coupled with its migratory use of the habitat, is important to consider in evaluating potential effects, and especially cumulative effects, of the Proposed Action. Unlike the situation in shorter-lived species, an individual bowhead whale may experience multiple disturbance effects from the proposed actions at different locations within the same season, at the same general location but at different times during the same year, and/or over different and multiple years. Because of their extreme longevity, should development and production occur in adjacent program areas (e.g. Chukchi and Beaufort seas) and over many years, probabilities indicate bowhead whales may be exposed to multiple pollution events (e.g. oil spills) over the course of their lifetime. In fact, many bowhead whales may already have been exposed to multiple events (see Sec. V.C.6.a, Analysis of Cumulative Effects).

Uncertainty should be acknowledged explicitly because it may point to areas that require monitoring and consideration of adaptive management. The species of whales under consideration in this section are large, endangered, baleen whales. The whale most likely to be exposed to the proposed activities is (are) the stock(s) of bowhead whales that inhabit the Bering-Chukchi-Beaufort Seas (BCB Seas). This group of whales is important to the viability of the species as a whole and is a species of very high importance for subsistence and to the culture of Alaskan Native peoples of the northern Bering Sea, the Chukchi Sea, and the Beaufort Sea. Especially because of the significance of any potential impacts (for the reasons given above), it is important to acknowledge what we know and what we do not. There are multiple sources of uncertainty in our analyses. These include, but are not limited to uncertainty about the action: where seismic surveys will occur; how many surveys will occur; how much noise will be produced purposely by the firing of airguns; what the exact shape of related ancillary activities, such as support-vessel type and activity will be; where exploration drilling could occur; where leases will be let; where a spill could occur; where production platforms and pipelines may be based; etc. More important, there is acknowledged (NRC, 2003, 2005; minutes from meetings of the Marine Mammal Commission Sound Advisory Panel, 2004, 2005 from their web site) scientific uncertainty about the potential effects of noise, especially repeated exposure to loud noise, on baleen whales. There is uncertainty and controversy regarding the potential effects of oil spills on large cetaceans. There are very few, if any, data available about potential effects of either noise or oil spills on cetacean calves. Lastly, and importantly, data are not available sufficient to characterize the current seasonal and temporal use of the Chukchi Sea Planning Area by bowheads and other whales, or to fully understand the importance of parts of the Beaufort Sea to bowhead whales. Thus, it is difficult to predict exposure in some parts of the area where the action could occur and to understand fully the potential effects of any exposure. However, while some sources of uncertainty cannot be reduced (e.g., long-term exposure to elevated noise levels) we can theoretically reduce overall uncertainty about potential impacts on baleen whales through requirements for monitoring. While in theory this is true, seismic surveys conducted in 2006 did encounter difficulty in implementing research monitoring requirements; for example, operators had difficulties in deploying acoustic-monitoring devices and were challenged when flying aerial surveys in nearshore areas. The MMS will implement an adaptive management approach to address the uncertainty about the effectiveness of research monitoring requirements, wherein field-monitoring techniques will be tailored (as needed) to address changing field conditions and logistical problems. We develop this approach in our discussion of mitigating measures in Section II.B.2.

Where there is uncertainty, the status of the population that could potentially be affected by our action relative to the species, and other important characteristics of the population, provides guidance into whether the analyses should be conservative and how precautionary the shape of the action should be. As discussed above and in the affected environment section, the BCB Seas stock of bowhead whale is the only stock of bowheads that is robust and well on its way to recovery from depletion due to commercial whaling. Thus, the population that could be exposed to the Proposed Action is important to the long-term viability of the species as a whole. This fact recommends a conservative (precautionary) approach to the analyses and the shaping of the action.

The bowhead's association with ice and its dependence upon the spring lead and polynya system make it problematic to extrapolate about the potential impacts of seismic noise, or other loud noise that could occur from information available about other species that have been exposed to such potential effectors in open water, or even from information about bowheads that have been exposed to seismic survey noise in open water. Unlike a species with less-constrained migratory pathways, bowhead whales are, over some of their migratory pathway, relatively fixed in at least part of the "road" they travel during spring migration.

The fact that the BCB Seas stock of bowheads is hunted throughout most of its range needs to be considered in evaluating the potential effects that MMS actions could have on this species. While we discuss this more fully in the section on cumulative effects, we note that geographic areas that exist in between areas where bowheads are hunted, and temporal periods in hunting areas in between periods when bowheads are hunted, may have more significance (e.g., as resting areas) to bowheads than they would if the species was not hunted. The fact that they are hunted also may heighten their response to oil and gas noise and disturbance, at least in some instances.

Current status and response to other perturbations is informative about potential response to the proposed actions. Based on available information, the bowhead population that may be affected is robust and resilient to a relatively steady lethal take in the subsistence hunt. This level of current mortality is below that which the IWC Scientific committee believes is sustainable for this population. We do not expect direct mortality on baleen whales from the Proposed Action but acknowledge that mortality could occur. However, it is clear that this population has continued to recover, despite previous activities that caused disturbance and lethal take. This continued recovery is informative about its resilience at least to the level of disturbance and take that have occurred within the past 20 years.

The MMS will not decrease monitoring and mitigating measures that were required during and prior to 1999 during pre- and postlease exploration activities to protect bowhead whales and to protect the availability of bowhead whales for taking by subsistence hunters unless data are available to indicate that such measures are not needed, do not provide protection, or if more effective measures should be applied in their place. As there have not been exploration activities in the Chukchi Sea since 1999, we also assume that certain pre-existing MMS measures to protect whales in the spring lead system will continue to be applied and that measures developed to protect whales, and the availability of whales to subsistence hunters in the Beaufort Sea, will be applied to the Chukchi Sea. We assume that these pre-existing measures will be in place unless the NMFS, through the ESA Section 7 consultation process, or through the issuance of an Incidental Harassment Authorization (IHA), concludes that such measures do not afford protection to the whales or do not afford protection to the availability of bowheads for take by subsistence hunters, or if NMFS identifies other measures that they require or recommend instead of these specific measures. Examples of pre-existing measures include:

- The MMS will not allow any seismic-survey operations in the Spring-lead-system (SLS) through the end of June or, as proscribed by NMFS as necessary to avoid potential adverse effects on the spring migration, on calving, on females with newborn calves, and on calves.
- Standard Stipulations apply for postlease activities, including seismic surveys (3D, 2D, and site-clearance surveys), during the bowhead whale migration and the subsistence bowhead whale hunt will apply. For example, under Lease 193 Stipulation 4, MMS requires companies to conduct site-specific bowhead whale-monitoring programs to determine when bowhead whales are present in the vicinity of lease operations and the extent of behavioral effects on bowhead whales due to these operations. The stipulation lists specific timeframes when the migration occurs for specific leases and when the stipulation applies. The requirements of this stipulation may be satisfied by a Letter of Agreement or IHA from NMFS. Lease 193 Stipulation 5 requires companies to consult with directly affected subsistence communities, the NSB, the AEWG, and appropriate agencies and co-management organizations [see Section II.B.3.c(1)] to discuss potential conflicts with the siting, timing, and methods of proposed operations, as well as safeguards or mitigating measures that could be implemented by the operator to prevent unreasonable conflicts.
- Information to Lessees (ITL) in a Proposed Notice of Sale. For example, in the Beaufort Sea Lease Sale 195 Proposed Notice of Sale (PNOS), ITL (d) states that 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 Sale 195 PNOS also states that the MMS and NOAA Fisheries

will establish procedures to coordinate results from site specific surveys required by Standard Stipulation 4 (Industry Site-Specific Bowhead Whale-Monitoring Program) and NOAA Fisheries LOAs or IHAs to determine if further modification to lease operations are necessary.

IV.C.1.f(1)(b) Potential Impacts from the Proposed Action Scenario. Multiple potential pathways exist through which endangered cetaceans, particularly bowhead whales, could be impacted by exploration, development, production, and abandonment actions in the Chukchi Sea Proposed Action area. In a recent review, Clapham and Brownell (1999) identified the potential pathways, evaluated the vulnerability of baleen whales to potential environmental degradation, and summarized that "...oil and gas development involves increased shipping traffic, seismic surveys, other noise, and the potential for catastrophic pollution events...."

IV.C.1.f(1)(b)1 Exploration. Many oil and gas exploration factors potentially could adversely affect ESA-protected cetaceans in and/or near the Chukchi Sea OCS. Disturbance pathways from vessel (ships, boats, and icebreakers) and aircraft traffic; seismic-survey-generated noise associated with 2D/3D seismic surveys; discharges from vessels; emplacement or construction of exploration platforms; and exploratory drilling could result. Additionally, endangered cetaceans conceivably could be disturbed or struck by ships or boats during exploration and adversely impacted by small fuel spills (defined elsewhere as all spills ranging between a tablespoon and <1,000 bbl).

IV.C.1.f(1)(b)2 Development. Based on prior OCS development, endangered cetaceans (especially the bowhead whale) potentially could be impacted by construction and development-associated noise; the activities associated with constructing production platforms and pipelines; production unit development; and shore-based facilities.

Marine vessels (including sealift and other barges, boats, and icebreakers) and aircraft likely would be used in OCS oil and gas development activities, and endangered cetaceans conceivably could be disturbed or struck by ships or boats. Potential small fuel spills also could occur. Any or all of these factors potentially could adversely affect ESA-protected cetaceans in and/or near the Chukchi Sea project area. There also are potential pathways of impact that are much less likely to occur and/or are not considered part of routine activities but that, based on data from previous development projects (USDOI, MMS, 2002; U.S. Army Corps of Engineers, 1999), have some estimable, but low, probability of occurring if a development project resulted from the proposed lease sale. This would include large oil spills (defined elsewhere as $\geq 1,000$ bbl).

IV.C.1.f(1)(b)3 Production. During production, noise and disturbance from the platform itself, drilling, marine vessels including crew boats and barges, aircraft, discharges, and oil spills from platforms or pipelines could adversely affect ESA-protected cetaceans. There also are potential pathways of impact that are less likely to occur and/or are not considered part of routine activities but that, based on data from previous production projects, have some estimable probability of occurring if a development project resulted from the proposed lease sale. This category would include large oil spills (defined elsewhere as $\geq 1,000$ bbl).

IV.C.1.f(1)(b)4 Abandonment. During abandonment, noise from platform removal and associated vessel traffic, habitat alteration, and potential pollution could result.

IV.C.1.f(1)(c) Potential Effects of Noise and Disturbances on Cetaceans. One of the greatest concerns associated with the impacts of oil and gas exploration and development on marine mammals has to do with potential impacts of noise on their ability to function normally and on their health. During OCS oil and gas pre- and postlease exploration, development, production, and abandonment activities, human-caused noise is transmitted through the air and through marine waters from a variety of sources including, but not limited to 2D/3D seismic surveys; pipeline, platform, and related shore base construction; drilling; platform abandonment; icebreaker and other ship, boat, and barge transit; high-resolution seismic surveys; and helicopter and fixed-winged aircraft traffic.

Because of the importance of this issue, two background sections are provided. The first provides very general information relevant to understanding the fate of noise in the marine environment. The second provides general background about potential types of effects of noise on marine mammals. After these

sections, the potential for each of the three species of whales to be exposed to oil and gas-related noise and disturbance in the Chukchi Sea Proposed Action area is summarized.

IV.C.1.f(1)(c)1) General Background on Noise in the Marine Environment. Properties of sound that influence how far that sound is transmitted, what species hear it, and what physical and behavioral effects it can have include its intensity, frequency, amplitude, wavelength, and duration; distance between the sound source and the animal; whether the sound source is moving or stationary; the level and type of background noise; and the auditory and behavioral sensitivity of the species (Richardson et al., 1995a). The frequency of the sound is usually measured in Hertz, pressure level in micropascals (Gausland, 1998), and intensity levels in decibels (dB) (Richardson et al., 1995a; McCauley et al., 2000). McCauley et al. (2000) and others cited therein express this in terms of its equivalent energy decibels re $1 \mu\text{Pa}^2$. The perceived loudness of any given sound is influenced by many factors, including both the frequency and pressure of the sound (Gausland, 1998), the hearing ability of the listener, the level of background noise, and the physical environment through which the sound traveled before reaching the animal.

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

1. Sound travels faster and with less attenuation in water than it does in air;
2. The fate of sound in water can vary greatly, depending on characteristics of the sound itself; characteristics of the location where it is released; characteristics of the environment through which it travels (Richardson et al., 1995a; McCauley et al., 2000); and the characteristics (for example, depth, orientation) of the receiver (Richardson et al., 1995a; Gausland, 1998);
3. Sound propagation can vary seasonally in the same environment;
4. Extrapolation about the likely impacts of a given type of sound source in a given location within the Chukchi Sea OCS project area on a particular marine mammal, based on published studies conducted elsewhere, are somewhat speculative because characteristics of the marine environment such as bathymetry, sound-source depth, and seabed properties greatly impact the propagation of sound horizontally from the source (McCauley et al., 2000; see also Richardson et al., 1995a:Ch. 4 and references provided therein). Richardson et al. (1995a:425) summarized that: "...a site-specific model of sound propagation is needed to predict received sound levels in relation to distance from a noise source." Especially within the Chukchi Sea project area, differences in site characteristics in different parts of the areas make predictions about sound propagation relative difficult;
5. There is a great deal of naturally occurring noise in the ocean from volcanic, seismic, wind, ice cracking, and even biotic sources (Richardson et al., 1995a:Ch. 5). Ambient noise levels affect whether a given sound can be detectable by a receiver, including a living receiver, such as a whale. Ambient noise levels can change greatly throughout the course of a season at a particular site, and vary from site to site; and
6. Because the air-water interface acts as a good reflector, sound generated underwater generally will not pass to the air (Gausland, 1998).

IV.C.1.f(1)(c)2) General Background on Potential Effects of Noise and Disturbance on Cetaceans.

Marine mammals rely on sound to communicate, to find mates, to navigate, to orient, to detect predators, and to gain other information about their environment. (Erbe and Farmer, 1998; Erbe et al., 1999; NRC, 2003, 2005). The scientific community generally agrees that hearing for cetaceans is an important sense (Richardson et al., 1995a,b; NRC, 2003, 2005; National Resources Defense Council (NRDC), 1999, 2005; Marine Mammal Commission Sound Advisory Panel Minutes from meetings, MMC website). Because of their reliance on hearing, there is an increasing concern about the impacts of proliferation of anthropogenic noise on marine mammals, especially cetaceans. The NMFS (Carretta et al., 2001) summarized that a habitat concern for all whales, and especially for baleen whales, is the increasing level of human-caused noise in the world's oceans.

Many factors exist that collectively determine whether or not potential effects of noise and disturbances on bowhead, humpback, or fin whales are adverse and likely to occur. For example, hearing (auditory) systems and perception are species-specific and habitat-dependent, and the fate of sound after it is produced is also habitat and, especially in the Arctic, season and weather dependent. Because of differences in

bathymetry and seabed characteristics of sites throughout the Chukchi Sea, the distances that sounds of various frequencies, intensities, and pressures will propagate, and the resulting effects such sounds could have, also are expected to differ greatly among specific sites (e.g., among specific lease blocks that differ in seabed properties, bathymetry, and the amount of wave action). Thus, the exact location of any sound source will determine the fate of sound released at that site and, therefore, will affect the possibility of impact on threatened and endangered cetaceans in or near the area. The time of year such sound is released will determine whether there is potential for individuals of a species to be exposed to that sound.

Noise from various sources has been shown to affect many marine mammals in ways ranging from subtle behavioral and physiological impacts to fatal (Olesiuk et al., 1995; Richardson et al., 1995a; Kraus et al., 1997; NRC, 2003, 2005). Increased noise could: (1) interfere with communication among whales; (2) mask natural sounds important to whales; (3) physiologically damage whales; and, (4) alter normal whale behavior, such as avoiding important areas (such as feeding areas) or displacing a migration route farther from shore.

Several important documents that summarize information on this topic include Richardson et al. (1995a); Hoffman (2002); Tasker et al. (1998); NRC (2003, 2005); NRDC (1999, 2005); International Whaling Commission [IWC] (2004a). Two particularly relevant summaries by the NRC have occurred within the last few years: *Ocean Noise and Marine Mammals* (NRC, 2003) and *Marine Mammal Populations and Ocean Noise, Determining when Noise Causes Biologically Significant Effects* (NRC, 2005). The IWC (2006) Scientific Committee Standing Working Group on Environmental Concerns held a meeting on seismic surveys and their potential impacts on marine mammals (available online at http://www.iwcoffice.org/sci_com/screport.htm). The Marine Mammal Commission (MMC) convened an Advisory Committee on Acoustic Impacts on Marine Mammals, which produced a report to the MMC (February 2006 – The Advisory Committee on Acoustic Impacts on Marine Mammals Report to the MMC, Feb. 1, 2006) detailing the views of six caucuses (available on their website at <http://www.mmc.gov/sound/> and in hard copy).

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

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

While there is scientific acknowledgement of this statement, there are few instances where data are sufficient to evaluate the total energy exposure of a marine mammal from a given source. At present, we do not have the data necessary to make such a determination or understand how it might change our analysis. The NMFS is preparing an EIS to evaluate the impacts of new acoustic criteria to evaluate take under the Marine Mammal Protection Act (MMPA).

Despite the increasing concern and attention noted above, there still is uncertainty about the potential impacts of sound on marine mammals; on the factors that determine response and effects; and especially on the long-term, cumulative consequences of increasing noise in the world's oceans from multiple sources (NRC, 2003, 2005). The NRC (2005) concluded that it is unknown how or in what cases responses of marine mammals to anthropogenic sound rise to the levels of biologically significant effects. This group also developed an approach of injury and behavioral "take equivalents". These take equivalents use a severity index that estimates the fraction of a take experienced by an individual animal. This severity index is higher if the activity could be causing harassment at a critical location or during a critical time (e.g., calving habitat). Because we have uncertainty about exactly where and how much activity will occur, the recommendations from the NRC (2005) are qualitatively incorporated in MMSs analysis.

Available evidence indicates that reaction to sound, even within a species, may depend on the listener's sex and reproductive status, possibly age and/or accumulated hearing damage, type of activity engaged in at the time or, in some cases, on group size. For example, reaction to sound may vary, depending on whether

females have calves accompanying them or whether individuals are feeding or migrating. It may depend on whether, how often, and in what context, the individual animal has heard the sound before. All of this specificity greatly complicates the ability, in a given situation, to predict the impacts of sound on a species or on classes of individuals within a species. Because of this, and following recommendations in McCauley et al. (2000), a protective approach is taken in our analyses and our conclusions about potential affects and impacts are based on the most sensitive members of a population. In addition, we make assumptions that sound will travel the maximums observed elsewhere, rather than minimums.

While there is some general information available, evaluation of the impacts of noise on marine mammal species, particularly on cetaceans, is greatly hampered by a considerable uncertainty about their hearing capabilities and the range of sounds used by the whales for different functions (Richardson et al., 1995a; Gordon et al., 1998; NRC, 2003, 2005). This is particularly true for baleen whales. Very little is known about the actual hearing capabilities of the large whales or the impacts of sound on them, especially on them physically. While research in this area is increasing, it is likely that we will continue to have great uncertainty about physiological effects on baleen whales because of the difficulties in studying them. 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). Thus, predictions about probable impacts on baleen whales generally are based on assumptions about their hearing rather than actual studies of their hearing (Richardson et al., 1995a; Gordon et al., 1998; Ketten, 1998).

Ketten (1998) summarized that the vocalizations of most animals are tightly linked to their peak hearing sensitivity. Hence, it is generally assumed that baleen whales hear in the same range as their typical vocalizations, even though there are no direct data from hearing tests on any baleen whale. Most baleen whale sounds are concentrated at frequencies <1,000 Hz. Bowhead whale songs can approach 4,000 Hz and calls can range between 50 and 400 Hz, with a few extending to 1,200 Hz (Richardson et al., 1995a). Based on indirect evidence, at least some baleen whales are quite sensitive to frequencies below 1,000 Hz 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 1,000 Hz (Richardson et al., 1995a). Seismic airguns are meant to produce low-frequency noise, generally below 200 Hz. However, the impulsive nature of the collapse of air bubbles inevitably results in broadband sound characteristics. Good (1966, cited in Stone, 2001) reported that high-frequency noise also is produced and found significant levels of energy from airguns across bandwidth up to 22 kilohertz (22,000 Hz). Some or all baleen whales may hear infrasounds, sounds at frequencies well below those detectable by humans. Functional models indicate that the functional hearing of baleen whales extends to 20 Hz. Even if the range of sensitive hearing does not extend below 20-50 Hz, whales may hear strong infrasounds at considerably lower frequencies. Based on work with other marine mammals, if hearing sensitivity is good at 50 Hz, strong infrasounds at 5 Hz might be detected (Richardson et al., 1995a). Bowhead whales, as well as blue and fin whales, are predicted to hear at frequencies as low as 10-15 Hz. McDonald, Hildebrand, and Webb (1995) summarize that many baleen whales produce loud low-frequency sounds underwater a significant part of the time. Thus, species that are likely to be impacted by low-frequency sound include baleen whales including bowheads.

Most marine mammal species also have the ability to hear beyond their peak range. This broader range of hearing probably is related to their need to detect other important environmental phenomena, such as the locations of predators or prey. Ketten (1998:2) summarized that:

The consensus of the data is that virtually all marine mammal species are potentially impacted by sound sources with a frequency of 500 Hz or higher. This statement refers solely to the probable potential for marine mammal species to hear sounds of various frequencies. If a species cannot hear a sound, or hears it poorly, then the sound is unlikely to have a significant effect. Other factors, such as sound intensity, will determine whether the specific sound reaches the ears of any given marine mammal.

Considerable variation exists among marine mammals in hearing sensitivity and absolute hearing range (Richardson et al., 1995a,b; Ketten, 1998). Because of suspected differences in hearing sensitivity, it is likely that baleen whales and pinnipeds are more likely to be harmed by direct acoustic impact from low to mid-sonic range devices than odontocetes (toothed whales). Conversely, odontocetes are more likely to be harmed by high-frequency sounds.

Little data are available about how, over the long term, most marine mammal species (especially large cetaceans) respond either behaviorally or physically to intense sound and to long-term increases in ambient noise levels. Large cetaceans cannot be easily examined after exposure to a particular sound source.

Whales often continue a certain activity (for example, feeding) even in the presence of airgun, drilling, or vessel sounds. Such continuation of activity does not confirm that the sound is not harmful to the cetacean. In many or all cases, this may be true: it may not be harmful. However, this type of interpretation is speculative. Whales, other marine mammals, and even humans, sometimes continue with important behaviors even in the presence of potentially harmful noise. Whales often fast for long lengths of time during the winter. The need to feed or to transit to feeding areas, for example, is possibly so great that they continue with the activity despite being harmed or bothered by the noise. For example, Native hunters reported to Huntington (2000) that beluga whales often ignore the approach of hunters when feeding, but at other times will attempt to avoid boats of hunters.

IV.C.1.f(1)(c)3 Potential Damage to Hearing. Ketten (1998) reported that hearing loss can be caused by exposure to sound that exceeds an ear's tolerance (i.e., exhaustion or overextension of one or more ear components). Hearing loss to a marine mammal could result in an inability to communicate effectively with other members of its species, detect approaching predators or vessels, or echolocate (in the case of the toothed whales).

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

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

Long-lasting increases in hearing thresholds, which also can be described as long-lasting impairment of hearing ability, could impair the ability of the affected marine mammal to hear important communication signals or to interpret auditory signals.

Most experiments have looked at the characteristics (e.g., intensity, frequency) of sounds at which TTS and permanent threshold shift occurred. However, while research on this issue is occurring, it is still uncertain what the impacts may be of repeated exposure to such sounds and whether the marine mammals would avoid such sounds after exposure, even if the exposure was causing temporary or permanent hearing damage, if they were sufficiently motivated to remain in the area (e.g., because of a concentrated food resource). There are no data on which to determine the kinds or intensities of sound that could cause a TTS in a baleen whale.

Permanent threshold shifts are less species-dependent and more dependent on the length of time the peak pressure lasts and the signal rise time. Usually, if exposure time is short, hearing sensitivity is recoverable. Hearing loss might be permanent if exposure to a sound is long, or if the sound is broadband in higher frequencies and has intense sudden onset. Repeated long exposures to intense sound or sudden onset of intense sounds generally characterize sounds that cause permanent threshold shift in humans. Ketten (1998) stated that age-related hearing loss in humans is related to the accumulation of permanent-threshold-shift and TTS damage to the ear. Whether similar age-related damage occurs in cetaceans is unknown.

A very powerful sound at close range can cause death due to rupture and hemorrhage of tissues in lungs, ears, or other parts of the body. At greater distance, that same sound can cause temporary or permanent hearing loss. Noise can cause modification of an animal's behavior (for example, approach or avoidance behavior, or startle).

Long-term impacts of OCS seismic-survey noise on the hearing abilities of individual marine mammals are unknown, and information about the hearing capabilities of large baleen whales is mostly lacking. As noted previously, the assumption is made that the area of greatest hearing sensitivity is at frequencies known to be used for intraspecific communication. However, because real knowledge of sound sensitivity is lacking, we believe it is prudent to assume in our analyses that sensitivities shown by one species of baleen whale also could apply to another. This reasonable approach provides the means to infer possible impacts on other species (such as the fin whale), especially when using studies on a species such as the humpback, which uses a large sound repertoire in intraspecific communication.

IV.C.1.f(1)(c)4 Potential Effects on Immune Function. Loud noise also may affect immune function. Romano et al. (2004:1125) summarized that “(A)nthropogenic sound is a potential ‘stressor’ for marine mammals. Not only can loud or persistent noise impact the auditory system of cetaceans, it may impact health by bringing about changes in immune function, as has been shown in other mammals....” These authors (Romano et al., 2004:1131) identified neural immune measurements that may be “implicated as indicators of stress in the white whale and bottlenose dolphin that were either released acutely or changed over time during the experimental period.” Specifically, they found significant increases in aldosterone and a significant decrease in monocytes in a bottlenose dolphin after exposure to single impulsive sounds (up to 200 kilopascals (kPa) from a seismic watergun. Neural-immune changes following exposure to single pure tones (up to 201 dB re 1 μ Pa) resembling sonar pings were minimal, but changes were observed over time. A beluga whale exposed to single underwater impulses produced by a seismic watergun had significantly higher norepinephrine, dopamine and epinephrine levels after high level sound exposure (> 100 kPa) as compared with low-level exposures (<100 kPa) or controls. Alkaline phosphatase decreased, but γ -glutamyltransferase increased over the experimental period.

IV.C.1.f(1)(c)5 Masking. When noise interferes with sounds used by the marine mammals (e.g., interferes with their communication or echolocation), it is said to “mask” the sound (a call to another whale might be masked by an icebreaker operating at a certain distance away). Noises can cause the masking of sounds that marine mammals need to hear to function (Erbe et al., 1999). The presence of the masking noise can make it so that the animal cannot discern sounds of a given frequency and at a given level that it would be able to in the absence of the masking noise. If sounds used by the marine mammals are masked to the point where they cannot provide the individual with needed information, they can cause harm (Erbe and Farmer, 1998). In the presence of the masking sounds, the sounds the animal needs to hear must be of greater intensity for it to be able to detect and to discern the information in the sound.

Erbe and Farmer (1998:1386) summarize that in “...the human and dolphin ear, low frequencies are more effective at masking high frequencies than vice versa; masking is maximized if the characteristic frequencies of the masker are similar to those of the signal....” They proposed that the factor most important for determining the masking effect of the noises was their temporal structure. The noise that was the most continuous with respect to frequency and time masked the beluga vocalization most effectively, whereas sounds (e.g., natural icebreaking noise) that occurred in sharp pulses that left quiet bands in between and left gaps through which the beluga could detect pieces of the call. In a given environment, then, the impact of a noise on cetacean detection of signals likely would be influenced by both the frequency and the temporal characteristics of the noise, its signal-to-noise ratio, and by the same characteristics of other sounds occurring in the same vicinity (for example, a sound could be intermittent but contribute to masking if many intermittent noises were occurring).

It is not known whether (or which) marine mammals can (Erbe and Farmer, 1998) and do adapt their vocalizations to background noise. Dahlheim (1987) reported that in noisy environments, gray whales increase the timing and level of their vocalizations and use more frequency-modulated signals.

IV.C.1.f(1)(c)6 Behavioral Reactions. Available evidence also indicates that behavioral reaction to sound, even within a species, may depend on the listener’s sex and reproductive status, possibly age and/or accumulated hearing damage, type of activity engaged in at the time or, in some cases, on group size. For example, reaction to sound may vary depending on whether females have calves accompanying them, whether individuals are feeding or migrating (for example, see discussion of impacts of noise on humpback whales in McCauley et al. [2000] and Sec. IV.B.1.f(3)(d)2) of the Cook Inlet multiple-sale EIS [USDOI, MMS, 2003b]). Response may be influenced by whether, how often, and in what context, the individual animal has heard the sound before. All of this specificity greatly complicates our ability, in a given

situation, to predict the behavioral response of a species, or on classes of individuals within a species, to a given sound. Because of this, and following recommendations in McCauley et al. (2000), a proactive approach is taken in our analyses and our conclusions about potential affects and impacts are based on the most sensitive members of a population. In addition, we make assumptions that sound will travel the maximums observed elsewhere, rather than minimums. This assumption may overestimate potential effects in many cases; however, since at least some of the airgun arrays being proposed for use in the Chukchi Sea have greater total output than many of those in previous studies, we may also underestimate impact in some cases.

IV.C.1.f(1)(d) Potential Effects from Seismic Surveys. Seismic-survey operations are sources of noise that potentially could disturb bowhead whales and other cetaceans in and near the areas to be surveyed. Noise can be transmitted through the air and through marine waters from a variety of seismic-survey sources including, but not limited to, 2D/3D and high-resolution seismic surveys that purposely release noise into the water (Sec. IV.A.3.b); icebreakers and other vessel transits; and helicopter and fixed-winged aircraft traffic. Endangered cetaceans also could be struck by vessels during seismic surveys and be impacted by small fuel spills. Any or all of these factors potentially could adversely affect ESA-protected cetaceans in and/or near the Chukchi Sea Project Area, but it is the noise generated by a seismic-survey airgun array that could generate the most impacts.

Richardson et al. (1995a:290-291) summarized: "Underwater sound pulses from airgun arrays and similar sources often are audible many tens of kilometers away." Transient noise from such a survey has been recorded on land seismometer arrays 6,100 km away after traveling the deep sound channel (Okal and Talandier, 1986). However, McDonald, Hildebrand, and Webb (1995) suggest that these same sounds may not have been detectable by a whale near the surface in the mid-Pacific because of entrapment in the deep sound channel. During monitoring using passive acoustics in the mid-Atlantic Ocean, Nieukirk et al. (2004) frequently recorded sounds from seismic airguns from locations more than 3,000 km from their array of autonomous hydrophones moored near the mid-Atlantic Ridge. Trends in the patterns of detection were similar in the 2 years of monitoring with airguns being detected every 10-20 seconds. Nieukirk et al. (2004:1838) reported that

Although airgun sounds tended to dominate recordings during the summer months, loud whale vocalizations could still be detected during intense airgun activity...The high received level of these impulses on multiple hydrophones made it possible to estimate the location of the ships conducting the airgun surveys.

IV.C.1.f(1)(d)1 High-Resolution Seismic Surveys. Bowheads appear to continue normal behavior when exposed to the sounds generated by high-resolution seismic surveys. In the study by Richardson, Wells, and Wursig (1985), four controlled tests were conducted by firing a single 40 cubic inches (in³) [0.66-Liters (L)] airgun at a distance of 2-5 km (1.2-3.1 mi) from the whales. Bowheads sometimes continued normal activities (skim feeding, surfacing, diving, and travel) when the airgun began firing 3-5 km (1.86-3.1 mi) away (received noise levels at least 118-133 dB re 1 μ Pa) rms (root-mean-square). Some bowheads oriented away during an experiment at a range of 2-4.5 km (1.2-2.8 mi) and another experiment at a range of 0.2-1.2 km (0.12-0.75 mi) (received noise levels at least 124-131 and 124-134 dB, respectively). Frequencies of turns, pre-dive 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.

High-resolution seismic surveys are unlikely to have a biologically significant effect on endangered whales, especially bowhead whales, because high-resolution seismic surveys are of short duration and their airguns generate lower energy sounds and have a smaller zone of influence than 2D/3D seismic surveys.

However, high-resolution seismic surveys conducted concurrently with 2D/3D seismic surveys and exploration/production drilling activities could cause local adverse impacts, if large numbers of bowheads are present at the same time. A concentration of seismic-survey noise and other disturbance-producing factors may keep bowhead whales from high habitat value areas, especially if high-resolution seismic-survey activity were to operate inshore of 2D/3D seismic survey activities or drilling operations. See Section V.C.6 for a discussion about the cumulative impacts of oil and gas activities on threatened and endangered marine mammals.

IV.C.1.f(1)(d)2 3D/2D Seismic Surveys. Numerous studies have been conducted (mostly east of the Chukchi Sea in the Beaufort Sea) on the effects of noise from seismic surveys on whales, especially bowhead whales. The results from these studies have varied, in some cases considerably, because of many variables, which include: (1) the type of seismic survey (ocean-bottom cable [OBC] vs. streamer); (2) the location of the study; (3) the year in which the study was conducted; (4) different study methodologies; (5) availability of bowhead whale habitat; and, (6) weather conditions.

In numerous study reports, it has been shown that multiple factors may be important in a whale's response to seismic-survey noise (McCauley et al., 2000). These factors include, but may not be limited to (1) the physical characteristics of the location into which the sound is released and the physical characteristics of the location where the whale is located at the time the sound is released; (2) the whale's sex and reproductive condition (e.g., groups with or without calves); (3) the behavior of the whale (e.g., migrating or feeding); (4) specific characteristics of the sound (e.g., frequency, duration, whether impulsive or not, etc.); and, (5) a whale's prior exposure to the sound. The studies involving the response of bowheads to 3D seismic surveys are most relevant to evaluating the potential effects of the Proposed Action.

Recent data are available regarding field-measured versus modeled noise-level radii associated with different seismic-survey arrays in shallow and very deep water (Tolstoy et al., 2004) that indicate some models may have been underestimating noise levels in shallow water. Because we assume that seismic surveys could occur anywhere within any portion of the Chukchi Sea Proposed Action area, and because the characteristics of the surveys themselves are likely to vary from those undertaken previously, we assume that the propagation characteristics also might vary from those determined during previous seismic activities. We summarize the information available about noise levels at distances determined or estimated during previous studies (primarily in the Beaufort Sea) and present and consider also the levels measured by Tolstoy et al. (2004).

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 (Ljungblad et al., 1988; Richardson, Würsig, and Greene, 1986). In general, many of the seismic surveys conducted during the 1980's were 2D seismic surveys that covered fairly large areas in a wide variety of areas. Additional studies on seismic surveys were conducted in the central Alaskan Beaufort Sea during the fall migration in 1996-1998. These surveys were 3D, OBC seismic surveys that covered smaller areas in relatively nearshore area.

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 km (1.86 mi) and as far away as 135 km (83.9 mi) from active seismic vessels. A pair of whales observed at a distance of 3 km (1.83 mi) 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 dB near the surface (depth of 3 m) than at deeper (>9 m) depths (Richardson et al., 1995a); therefore, 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 km (83.9 mi), 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. Reeves, Ljungblad, and Clarke (1983) 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 correlated dictates caution in attempting to establish causative explanations from the preliminary findings.

Ljungblad et al. (1985) also reported findings from early tests of bowhead reactions to active seismic vessels in the Beaufort Sea. Methodological problems with this early study preclude conclusions about potential bowhead reactions based on its findings. A subcommittee of the Scientific Committee of the IWC previously reviewed the data from this study, 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 subcommittee acknowledged the difficulty of performing experiments of this kind, particularly in the absence of a control environment free of industrial noise. The subcommittee 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 could be used to draw any conclusions about the effects of seismic activity on this species (IWC, 1987).

In Fraker et al. (1985), an active seismic vessel traveled toward a group of bowheads from a distance of 19 km (11.8 mi) to a distance of 13 km (8.18 mi). 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 km (1.86 mi). 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-L airgun array (estimated source level 245-252 dB re 1 μ Pa), bowheads began to orient away from the approaching ship when its airguns began to fire from 7.5 km (4.7 mi) away. This airgun array had about 30 airguns, each with a volume of 80-125 in³. The *Mariner* had been shooting seismic about 10 km 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 km 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 km (4.7 mi) away. The bowheads continued to surface and dive, moving at slow to medium speeds. The received level was estimated at 134-138 dB at 7 km (4.35 mi). Some near-bottom feeding (evidenced by mud being brought to the surface) continued until the vessel was 3 km (1.86 mi) away. The closest point of approach to any whale was approximately 1.5 km (0.93 mi), with the received level probably well over 160 dB. When the seismic vessel was within 1.5 km of whales at the original location, at least two of the whales were observed to have moved about 2 km 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 km 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 km 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 km (14.3-16.8 mi) from the drillship. A seismic vessel was reported to be from 120-135 km (74.58-83.9 mi) from the sonobuoy; the two loudest calls received were determined to be approximately 7 km (4.35 mi) and 9 km (5.6 mi) from the sonobuoy, with received levels of 119 and 118 dB, respectively. Approximate signal-to-noise ratios were 24 and 22 dB, 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 km (13.7-14.9 mi). The received level of seismic pulses was 137 dB at 19 km (11.8 mi) from the sonobuoy and 22 km 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.

Based on early data, Richardson and Malme (1993) concluded that collectively, scientific studies showed that most bowheads usually show strong avoidance response when an operating seismic vessel approaches

within 6-8 km (3.8-5.0 mi). Based on those early data, they believed that strong avoidance occurred when received levels of seismic noise are 150-180 dB re 1 μ Pa (Richardson and Malme, 1993). 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. Bowhead surface-respiration-dive characteristics appeared to recover to pre-exposure levels within 30-60 minutes following the cessation of the seismic activity. Strong pulses of seismic noise were often detectable 25-50 km (15.5-31 mi) from seismic vessels, but in early studies, bowheads exposed to seismic sounds from vessels more than about 7.5 km (4.7 mi) away rarely showed avoidance. As noted above, seismic pulses can be detectable 100 km (62.2 mi) or more away and in some habitats, have been detected at distances from the source more than ten times that distance. 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.

The NSB believes that many of the early studies were different from the real-world situation, and various and important limitations of these studies 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. 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 suggested that the fall bowhead migration tended to be farther offshore when there was abundant seismic work 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 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 farther 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 (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 km (7.76 and 18.6 mi) from shore. Although the analysis involved a relatively small sample size, these observations provide some insight into migration patterns during these years. In a letter dated July 25, 1997, the NSB 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.

Using larger sample sizes (for which confidence intervals (CI) 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 ($P < 0.05$) (Treacy, 1997). Median depths ranged between 18 m (59 ft) in 1989 and 347 m (1,138 ft) in 1983, with an overall cumulative depth of 37 m (121 ft, CI = 37-38 m). 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 m (1,138 ft) deep. To address short-term bowhead whale displacement within a given year from site-specific industrial noise, MMS and NMFS require industry to conduct site-specific monitoring programs when industrial activity occurs in the Beaufort Sea Planning Area during fall bowhead migrations.

Since 1996, many of the open-water seismic surveys in State of Alaska waters and adjacent nearshore Federal waters of the central Alaskan Beaufort Sea were OBC surveys. These surveys were 3D seismic programs. The area to be surveyed is divided into patches, each patch being approximately 5.9 by 4.0 km 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-in³ array with 8 airguns, and the largest, a 1,500-in³ array with 16 airguns. Airgun arrays used in the 2006 open-water season were as large as 3,100 in³. A marine mammal and acoustical monitoring program was conducted in conjunction with the seismic program each year in accordance with provisions of the NMFS IHA.

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 km of active seismic operations. 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 km to the east. Some bowheads approached within 19-21 km 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 km west of the area of seismic operations. In contrast, during 1996-1997, there were several sightings in areas 25-40 km west of the most recent shotpoint, indicating the deflection in 1996-1997 may not have persisted as far to the west.

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). Details of these studies are provided in the Beaufort Sea multiple-sale final EIS (USDOI, MMS, 2003a).

These studies indicated 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. Aerial survey results indicated that bowheads tended to avoid the area around the operating source, perhaps to a radius of about 20-30 km.

Richardson (1999) reported that within 12-24 hours after seismic-survey operations ended, the sighting rate within 20 km was similar to the sighting rate beyond 20 km; however, the sighting rate within 20 km was statistically lower than beyond 20 km even 96 hours after seismic survey operations. Overall, the 1996-1998 results show that most bowheads avoided the area within about 20-30 km of the operating airguns. The observed 20-30 km area of avoidance is a larger avoidance radius than documented by previous scientific studies in the 1980's and smaller than the 30 mi suggested by subsistence whalers, based on their experience with the types of seismic operations that occurred in the Beaufort Sea before 1996 (Richardson, 2000). The seismic-survey activities in the 1980's were 2D, whereas the recent seismic activities were 3D OBC.

Based on recordings of bowhead whale calls made during these same studies, Greene et al. (1999) summarized that results for the 3 years of study indicated 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 the call-detection rate to change in a consistent way at times when airguns started or stopped.

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). Richardson provided a brief comparison between observations from seismic studies conducted in the 1980's and the 1996 seismic survey at the Arctic Seismic Synthesis Workshop in Barrow (USDOI, MMS,

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 survey ship approaches within about 7.5-8 km. At the distances where this strong avoidance occurs, received levels of seismic pulses typically are high, about 150-180 dB re 1 μ Pa. 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.

At least one case of strong avoidance has been reported as far as 24 km from an approaching seismic boat (Koski and Johnson, 1987) and, as noted above, the aerial-survey data (Miller et al., 1999) indicated that bowheads tended to avoid the area around the operating source, perhaps to a radius of about 20-30 km.

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.

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 in³) 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 1 μ Pa rms and 107-126 dB re 1 μ Pa 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-in³ arrays of 24 sleeve-type airguns. Each 2,250-in³ airgun array was comprised of 24 airguns with volumes ranging from 40-150 in³. The two airgun arrays fired alternately every 8 seconds along the survey lines. The airgun arrays were operated at a depth of 5 m below the water surface. Water depths within the surveyed areas ranged from 6-31 m and averaged 13 m (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 NMFS recommended criterion that exposure of whales to impulse sound not exceed 180 dB re 1 μ Pa rms (65 FR 16374, Small Takes of Marine Mammals Incidental to Specified Activities: Marine Seismic-Reflection Data Collection in Southern California. Notice of Receipt of Application) 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 1,000-m safety radius for

whales (the estimated zone within which received levels of seismic noise were 180 dB re 1 μ Pa rms or higher).

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 airguns (a mean radial distance of 1,368 m) versus line-seismic periods (a mean radial distance of 1,957 m). 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 m) but significant difference in sighting distances suggests that the avoidance may have been localized and relatively small in nature. At a minimum, the distance by which bowheads avoided seismic operations was on the order of 600 m greater than the average distance by which they avoided general vessel operations. The lower sighting rates recorded during seismic operations suggests 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*.

In this study, 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 feeding-seismic sample was too small for meaningful comparisons. Bowheads were seen regularly within 20 km of the operations area at times influenced by airgun pulses. Of 169 transect sightings in good conditions, 30 sightings were seen within 20 km of the airgun operations at distances of 5.3-19.9 km. 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 m) would have been exposed to sound levels of about 180 dB re 1 μ Pa 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 km of the seismic vessel. Bowheads at the average vessel-based sighting distance (1,957 m) during line seismic would have been exposed to sound levels of about 170 dB re 1 μ Pa rms. The many aerial sightings of bowheads at distances from the vessel ranging from 5.3-19.9 km would have been exposed to sound levels ranging from approximately 150-130 dB re 1 μ Pa rms, respectively.

The results from the 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 km) than that observed for migrating bowhead whales in recent autumn studies in Alaskan waters (up to 20-30 km). 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). Whalers have reported reaction distances, where whales begin to divert from their migratory path, on the order of 10 mi (T. Albert cited in USDO, MMS, 1995a) to 35 mi (F. Kanayurak, cited in USDO, MMS, 1997). Kanayurak stated that the bowheads "...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 3) placing physical barriers between the subsistence whalers and marine mammals, including altering the normal bowhead whale migration route.

There also are data on the effect of seismic surveys on other species that are useful in interpretation of effects on baleen whales, including bowheads. Below, we review information from McCauley et al. (2000) regarding the responses of humpbacks to seismic surveys in Australia. More recently, at its mini-symposium on acoustics in July 2004, the IWC Scientific Committee Standing Working Group on Environmental Concerns discussed information related to a stranding of humpbacks in Brazilian waters, coincident in time with seismic surveys in the area. During the 2002 breeding season, during the same time that seismic surveys were being conducted on breeding grounds in Brazilian waters, eight strandings of adult humpback whales were reported, a frequency nearly 27% of the total stranding of adults reported in Brazilian waters between 1975 and 2003; however, no clear causes of the strandings were identified or inferred. The IWC Scientific Committee Standing Working Group on Environmental Concerns also discussed information related to a potential displacement by seismic surveys of western Pacific gray whales from a feeding area off of Sakhalin Island (IWC, 2004a,b). Based on their discussions during the mini-symposium, both the IWC as a whole and its Scientific Committee agreed that there is compelling evidence of increasing sound levels, including sound from ships and seismic activities.

Weller et al. (2004) tested the hypothesis that the distribution of feeding western gray whales would shift away from seismic surveys by comparing the number of feeding western gray whales and the number of pods sighted during systematic scans conducted before, during, and after 3D seismic surveys. These authors found that both the number of whales and the number of pods sighted were significantly different during 3D seismic surveys than before and after the surveys. Noting that this population depends on the area studies for the majority of its annual food intake and is critically endangered, these authors (Weller et al., 2004:1) concluded that: "Disruption of feeding in preferred areas is a biologically significant event that could have major negative effects on individual whales, their reproductive success, and thus the population as a whole."

Several summaries related to the potential effects of seismic surveys have been written (Richardson et al., 1995a,b; McCauley et al., 2000; Gordon et al., 1998, 2004). Gordon et al. (1998:Sec. 6.4.3.1) summarized that: "Given the current state of knowledge, it is not possible to reach firm conclusions on the potential for seismic pulses to cause...hearing damage in marine mammals." Later in this review, they reach the same conclusion about the state of knowledge about the potential to cause biologically significant masking. "This review has certainly emphasized the paucity of knowledge and the high level of uncertainty surrounding so many aspects of the effects of sound on marine mammals" (Gordon et al., 1998:Sec. 6.12). While uncertainty is reduced, the statements above are still accurate.

The Scientific Committee of the International Whaling Commission (IWC) reviewed information about the potential impacts from seismic survey operations on marine mammals (especially on bowhead whales) at its 2006 meeting and made several recommendations. These recommendations included the need to better understand the high sensitivity of bowhead whales to low levels of industrial sounds; the need to document areas important for bowhead whales in regions within which seismic operations are proposed; and, the need to develop a better understanding of the biological significance of impacts from seismic survey activities.

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).

Potential Differential Responses of Male and Female Whales. McCauley et al. (2000) recently demonstrated that pods of humpback whales containing cows involved in resting behavior in key habitat were more sensitive to airgun noise than males and than pods of migrating humpbacks. In 16 approach trials carried out in Exmouth Gulf, off Australia, he found that pods of humpbacks with females

consistently avoided a single (not an array) operating airgun at an average range of 1.3 km (McCauley et al., 2000). McCauley et al. (2000) summarized:

The generalized response of migrating humpback whales to a three-dimensional seismic vessel was to take some avoidance maneuver at greater than 4 kilometers then to allow the seismic vessel to pass no closer than 3 kilometers. Humpback pods containing cows which were involved in resting behavior in key habitat types, as opposed to migrating animals, were more sensitive and showed an avoidance response estimated at 7-12 kilometers from a large seismic source.

McCauley et al. (2000) observed a startle response in one instance. Within the key habitat areas where resting females and cow/calf pairs occurred, the humpbacks showed high levels of sensitivity to the airgun. The mean airgun level at which avoidance was observed was 140 dB re 1 μ Pa (rms), the mean standoff range was 143 dB re 1 μ Pa (rms), and the startle response was observed at 112 dB re 1 μ Pa (rms). Standoff ranges were 1.22-4.4 km. The noise levels at which response was detectable were less than those observed by McCauley et al. (2000) in observations made from the seismic vessel operating outside of the sensitive area where whales were migrating, not engaged in a sensitive activity.

McCauley found that adult male humpbacks were much less sensitive to airgun noise than were females. At times, they approached the seismic vessel. McCauley et al. (2000) speculated that males that did so may have been attracted by the sound because of similarities between airgun sounds and breaching signals.

Based on the aforementioned, it is likely that humpback whales feeding in areas within and adjacent to areas within the Proposed Action area could have their movement and feeding behavior affected by noise associated with seismic exploration. The most likely to be impacted are cow/calf pairs. This potential impact would be seasonal, since humpbacks are not common in these areas during the winter.

IV.C.1.f(1)(d)3 Effects of Noise from Icebreakers. If seismic-survey vessels are attended by icebreakers (serving as support vessels), additional disturbance and noise could be introduced by the icebreaker. The MMS does not expect active ice management as part of seismic surveying. Rather, if icebreaking occurs, it would only be used to assist a vessel exiting from the Chukchi Sea.

Based on models in earlier studies, Miles, Malme, and Richardson (1987) predicted that bowhead whales likely would respond to the sound of the attending icebreakers at distances of 2-25 km (1.24-15.53 mi) from the icebreakers. 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 km (1.25-7.46 mi) when the sound-to-noise ratio is 30 dB. 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 km (2.86-12.4 mi) when the sound-to-noise ratio is 30 dB.

Richardson et al. (1995a:Table 6.5) provided source levels at 1 m for icebreaker noise. For example, they note that noise levels from the M/S *Voima* in open water at 50-60% power had broadband-noise levels of 177 dB re 1 μ Pa-m, whereas the source level when icebreaking full astern was 190 dB re 1 μ Pa-m.

Response distances of bowheads to icebreakers are expected to vary, depending on the size, engine power, and mechanical characteristics of the icebreaker, vessel activities, sound-propagation conditions, the types of individuals exposed, and the activities they are engaged in when exposed. 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 dB or more above the natural ambient noise levels at corresponding frequencies. They pointed out that the source level of an actual icebreaker is much higher than that of the projectors (projecting recorded sound) used in their study (median difference 34 dB over the frequency range 40-6,300 Hz). Over the two-season period, they observed a difference in the estimated numbers of bowheads seen near the ice camp when the projects were quiet (approximately 158 bowheads in 116 groups) versus when icebreaker sounds were being transmitted into the water (an estimated 93 bowheads in 80 groups). Some but not all bowheads diverted from their course when exposed to levels of projected icebreaker sound >than 20 dB above the natural ambient noise level in the one-third octave band of the strongest icebreaker noise and a minority of whales apparently diverted at a lower sound-to-noise ratio.

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. For example, infrasounds that may be associated with icebreakers were not adequately represented in playback transmissions. Bowhead whales likely hear or can detect infrasounds (Richardson et al., 1995b).

Richardson et al. (1995b:322) summarized that:

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 dB around the “typical” threshold, with commensurate variability in predicted reaction radius.

Richardson et al. (1995b:xxi) stated that:

If bowheads react to an actual icebreaker at source to noise and RL values similar to those found during this study, they might commonly react at distances up to 10-50 km from the actual icebreaker, depending on many variables. Predicted reaction distances around an actual icebreaker far exceed those around an actual drillsite...because of (a) the high source levels of icebreakers and (b) the better propagation of sound from an icebreaker operating in water depths 40+ m than from a bottom-founded platform in shallower water.

Richardson et al. (1995b) stated that predicted response distances for bowheads would be highly variable around an actual icebreaker. They predicted that detectable effects on behavior and movements for “typical traveling bowheads” extend commonly out to radii of 10-30 km (6.2-18.6 mi) and sometimes to 50+ km. They noted that given the factors influencing reaction distances and the observed reactions to playbacks of icebreaker noise “Predicted reaction distances for bowheads around an icebreaker like the *Robert Lemeur* vary from as little as ~2 km to as much as 95 km.”

Richardson et al. (1995b:xxii) 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 bowheads visible in the open water of nearshore lead systems during spring migration east of Pt. Barrow. Reaction distances around an *actual icebreaker* like *Robert Lemeur* are predicted to be much greater, commonly on the order of 10-50 km. Effects of an actual icebreaker on migrating bowheads, especially mothers and calves, could be biologically significant.

The highest potential for avoidance probably would occur if both seismic surveys and icebreaking occur within an area in which a high level of use by bowheads also is occurring. Because we do not expect ice management as part seismic surveying, MMS does not expect a significant effect on bowhead whales from icebreaker activities.

IV.C.1.f(1)(d)4 Effects from Other Vessel Traffic Associated with Seismic Surveys. According to Richardson and Malme (1993), most bowheads begin to swim rapidly away when vessels approach rapidly and directly. This avoidance may be related to the fact that bowheads have been commercially hunted within the lifetimes of some individuals within the population and they continue to be hunted for subsistence throughout many parts of their range. Avoidance usually begins when a rapidly approaching vessel is 1-4 km (0.62-2.5 mi) away. A few whales may react at distances from 5-7 km (3-4 mi), and a few whales may not react until the vessel is <1 km (<0.62 mi) away. Received noise levels as low as 84 dB re 1 μ Pa (rms) or 6 dB above ambient may elicit strong avoidance of an approaching vessel at a distance of 4 km (2.5 mi) (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 km (1.2-2.5 mi) and to move away at increased speeds when approached closer than 2 km (1.2 mi) (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.

Data are not sufficient to determine sex, age, or reproductive factors that may be involved in response to vessels. The MMS is not aware of data that would determine whether females with calves tend to show avoidance and scattering at a greater, lesser, or at the same distances as other segments of the population.

The encounter rate of bowhead whales with vessels associated with exploration would be determined by what areas were being explored. Data are insufficient for us to accurately predict the average geographic zone of activity by the support vessels and thus, to predict the additional area that could be affected by the vessels.

Bowhead whales could encounter noise and disturbance from multiple seismic vessels and multiple support vessels as they migrate and feed in the Chukchi Sea. The significance of such encounters is expected to depend on the area in which the vessels are transiting, the total number of vessels in the area, the presence of other vessels (see cumulative effects section), and variable already identified regarding the number, behavior, age, sex and reproductive condition of the whales.

Depending on ice conditions, it is likely that vessels moving from one site to another would be more disturbing to whales than vessels idling or maintaining their position. Bowheads probably would adjust their individual swimming paths to avoid approaching within several to several dozen kilometers. Vessel activities associated with seismic surveys are not expected to disrupt the bowhead migration but may cause avoidance of certain areas. Small deflections in individual bowhead-swimming paths are not expected to be significant in any individuals, but a reduction in use of possible bowhead-feeding areas near exploration units may result in adverse effects. 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 really extensive and too thick for seismic-survey ships and supply vessels to operate in. Because MMS is not allowing seismic-survey activities in the spring lead system until July 1 unless authorized by NMFS, we do not expect seismic survey vessel interaction to be an important source of disturbance during the northward migration.

In addition to acting as a source of noise and disturbance, marine vessels potentially could strike bowhead whales, causing injury or death. The frequency of observations of vessel-inflicted injuries suggests that the incidence of ship collisions with bowhead whales is low but may be increasing. Between 1976 and 1992, only 3 ship-strike injuries were documented out of 236 whales examined from the subsistence harvest (George et al., 1994). Between 1995 and 2002, ship-strike injuries were observed on 6 additional whales out of 180 (NMFS, 2003, citing George, pers. commun.). The low number of observed ship-strike injuries suggests that either bowheads do not encounter vessels; they avoid interactions or interactions result in the animal's death. However, available information does not indicate that strikes of bowheads by seismic-survey-related vessels will become an importance source of injury or mortality.

IV.C.1.f(1)(d)5 Effects from Aircraft Traffic. 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 m (500 ft). At altitudes below 150 m (500 ft), some bowheads probably would dive quickly in response to the aircraft noise

(Richardson and Malme, 1993). 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 m (500 ft) or less and lateral distances of 250 m or less. The most common reactions were abrupt dives and shortened surface time and most, if not all, reactions seemed brief. The majority of bowheads, however, showed no obvious reaction to single passes, even at those distances. The helicopter sounds measured underwater at depths of 3 and 18 m showed that sound consisted mainly of main-rotor tones ahead of the aircraft and tail-rotor sounds behind the aircraft; more sound pressure was received at 3 m than at 18 m; and peak sound levels received underwater diminished with increasing aircraft altitude. Sound levels received underwater at 3 m from a Bell 212 flying overhead at 150 m (500 ft) ranged from 117-120 dB re 1 μ Pa in the 10- to 500-Hz band. Underwater sound levels at 18 m from a Bell 212 flying overhead at 150 m ranged from 112-116 dB re 1 μ Pa in the 10- to 500-Hz 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 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) 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 m. 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 m or less and lateral distances of 250 m or less. There was little, if any, reaction by bowheads when the aircraft circled at an altitude of 460 m and a radius of 1 km. The effects from an encounter with aircraft are brief, and the whales should resume their normal activities within minutes.

While the obvious behavioral reaction of a bowhead to a single low-flying helicopter or fixed-winged aircraft flying overhead probably is temporary (Richardson et al., 1995a), most "fleeing" reactions in mammals are accompanied by endocrine changes, which, depending on other stressors to which the individual is exposed, could contribute to a potentially adverse effect on health.

The greatest potential for helicopter or fixed-wing aircraft to cause adverse effects on bowhead whales exists in areas where bowheads are aggregated, especially if such aggregations contain large numbers of cow/calf pairs. We discuss these areas at the end of our discussion of the potential effects of particular affecters.

Such potential fleeing reactions likely would be considered in incidental take authorizations. Flight practices could be structured by the helicopter operators to avoid such interactions. Potential effects on bowheads from aircraft are relatively easily avoided by flight practices requiring fixed-wing flights above 1,000 ft and avoidance by helicopters of areas where bowheads are aggregated.

IV.C.1.f(1)(d)6 Areas and Situations Where Potential Impacts are Likely to be Greater than Typical. Bowheads are not randomly distributed throughout the Proposed Action area. The extent of use of particular habitats varies among years, sometimes considerably; therefore, it is difficult to predict, in advance of a given year, exactly how bowheads will use the entire area that is available to them. Some aspects of their habitat use are poorly understood. For example, current data are not available on which to typify the current summer use of the northern Chukchi Sea by bowheads. For example, in the Beaufort Sea in some years, large aggregations of bowheads near Smith Bay have been observed during MMS' Bowhead Whale Aerial Survey Program (BWASP) surveys at the beginning of September. It is unclear if these animals are early migrants that have come from the east, if they summered in the northern portions of the Beaufort Sea and came south, or if they entered from the Chukchi Sea and never migrated east. Figure III.B-2 depicts counts in the Chukchi Sea. It is important to note that the Chukchi Sea data are not recent (1979-1991) and thus should not be interpreted as indicating current patterns of bowhead use of the Chukchi Sea. While it is clear that seismic activity may overlap with bowhead use of the Chukchi Sea during fall migration, it is highly uncertain about the likely extent of overlap between seismic activity and bowhead whales in the summer. During fall migration, available, but dated, data indicate that overlap is

likely to be greatest in the main migratory pathways, one heading nearly directly to the Bering Strait, and the other heading west from Barrow towards Wrangell Island.

It is clear that if 2D/3D seismic surveys impacted areas of the spring lead and polynya system during the spring migration, impacts could potentially be biologically significant. We note that the general location of the spring lead system in the Chukchi Sea (and 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 including females with newborn calves. This situation is not expected to occur because MMS will not permit seismic surveys in this system through the end of June. Thus, 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, (2) sufficient open water may not be present for open-water seismic surveys, and (3) MMS will not permit surveys in the lead system until July 1, unless authorized by NMFS.

If 2D/3D seismic surveys occurred in areas when large aggregations of whales were present, and particularly if multiple 2D/3D seismic surveys occurred concurrently in these areas, large numbers (hundreds) of bowheads potentially could be disturbed by the survey activity or could be excluded by avoidance from habitat for the period the surveys were occurring. The timeframe over which 2D/3D seismic surveys are likely to occur in a given area is variable, depending on the size of the area being surveyed as well as the percentage of time when the boat is inactive. However, it would not be atypical for a seismic survey vessel to be in a given area for 20-30 days.

Considering only seismic activity, and ignoring other potential human uses of an area, MMS considered a relatively crude scenario where many seismic vessels in a given area were interested in collecting seismic data from the same general area. This admittedly simplistic scenario does not include any avoidance of support vessels, attraction of prey that might be in the area, sizes of the areas being surveyed, turning requirements for the vessels, or the fact that, unless the vessels all moved in tandem, this area would be larger if the vessels moved further apart. The scenario does provide an opportunity for obtaining a simplistic area of avoidance under the following assumptions: (1) the seismic vessels are no more distant from each other than the minimum separation of 15 mi that MMS requires; and (2) most bowhead whales may avoid approaching an active seismic vessel from a distance of about 20-30 km (e.g., see study results provided above and summary in Appendix A of LGL Alaska Research Assocs. and LGL Ltd., 2005), which is the distance exhibited by migrating bowhead whales in response to ocean bottom cable seismic surveys in the Alaskan Beaufort Sea at estimated received levels of about 116-135 dB re 1 μ Pa rms. We caution that this exercise is simply an attempt to gauge an approximate "ballpark" idea of the extent of the area that might be avoided.

Data indicate that bowhead reaction to seismic impacts varies, and could be lower in some cases if bowheads are in an area feeding (e.g., strong avoidance at ~3-7 km) (e.g., see Richardson, Würsig, and Greene, 1986; Richardson et al., 1995a), but could also be higher during migration (e.g., up to 35 km in some cases), especially if much larger air guns were used in the Chukchi Sea than those used in surveys in the Beaufort Sea during the late 1990's. Given these assumptions, an instantaneous area being avoided by bowheads in all directions could be as much as 112-132 km x 40-60 km. If seismic surveying is being conducted in relatively nearshore blocks (e.g., within 20-30 km of wherever the bowheads' most shoreward-migratory pathway would be), seaward movement could be constrained by the presence of offshore ice. Such clumping of activities could occur, if different companies were all interested in a similar geological prospect and were spaced as near to one another as MMS requirements would allow. The extent of avoidance will vary both due to the actual noise level radii around each seismic vessel, the context in which it is heard, and the motivation of the animal to stay within the area. It also may vary depending on the age, and most likely, the sex and reproductive status of the whale. It also may be related to whether subsistence hunting has begun and/or is ongoing.

If restrictions were put on the number of operators that could operate simultaneously, within a single season, within a specified geographic area, the total area in the evaluation area excluded by avoidance would rise, but the simultaneous geographic impacts in a given area would be lessened. This potential strategy trade-off could be important in reducing effects in high value areas. The MMS and NMFS can restrict operations if additive synergistic effects occur from simultaneous seismic surveys that might hinder the whales' migration.

Because areas where large aggregations of whales have been observed during the autumn are also areas used, at least in some years, for feeding, it may be that the whales would show avoidance more similar to that observed in studies of whales on their summer feeding grounds. As noted above, it is not clear that reduced avoidance should be interpreted as a reduction in impact because bowheads may be highly motivated to stay on a feeding ground and with long term exposure, be adversely affected. The first situation could arise if bowheads use the Chukchi Sea in the summer more than is commonly assumed, especially for feeding and if large numbers of cow/calf pairs remain in the Chukchi Sea. The second situation for possibly larger than typical impacts exists in the Chukchi Sea in the autumn (e.g., late September on) as whales migrate both towards the Asian coast and toward the Bering Strait. Insufficient data exist to determine the current migration paths or the numbers of whales that might be deflected from those paths. Data are also not available to determine how intensively bowheads feed during the autumn migration in the Chukchi Sea or whether large aggregations exist in certain places due to prey resources.

IV.C.1.f(1)(d)7) Effects from Small Oil Spills Associated with Seismic Surveys. Large oil spills are not expected during the course of seismic-survey exploration. Small fuel spills associated with the vessels used for seismic exploration could occur, especially during fuel transfer. There could be localized short-term alterations in bowhead habitat and its use as a result of such a spill. Whales exposed to a small fuel spill likely would experience temporary or potentially permanent nonlethal effects. Data available from other mammals indicates that prolonged exposure, or particularly exposure of nursing young to spilled oil, could potentially result in temporary or potentially permanent sublethal effects. For example, ingestion of oil reduces food assimilation and thereby reduces the nutritional value of food. However, it is unlikely such an impact would be detectable. These conclusions are supported by the best available information. There are no data available to MMS that definitely link even a large oil spill with a significant population-level effect on a species of large cetacean. The greatest potential for an adverse effect would be if a large fuel spill (e.g., due to vessel sinking) occurred in the Chukchi Sea and affected the spring lead system. The potential for there to be adverse effects from a fuel oil spill would also likely be greater (than in more typical circumstances) if a large spill of fuel oil (with high concentrations of aromatics) contacted one or more large aggregation of bowheads. The probability of such an accident occurring and affecting this habitat is unlikely.

Copepods may passively accumulate aqueous polyaromatic compounds (PAC's) from water and could thereby serve as a conduit for the transfer of PAC's to higher trophic-level consumers. Bioaccumulation factors were ~2,000 for *M. okhotensis* and about ~8,000 for *C. marshallae*. *Calanus* and *Neocalanus* copepods have relatively higher (Duesterloh, Short, and Barron, 2002). A small fuel spill would not permanently affect zooplankton populations, the bowhead's major food source. The amount of zooplankton lost in a small fuel spill would be small compared to what is available on the whales' summer-feeding grounds (Bratton et al., 1993).

The potential effects to bowheads of exposure to PAC's through their food are unknown. Because of their extreme longevity, bowheads are vulnerable to incremental long-term accumulation of pollutants. With increasing development within their range and long-distance transport of other pollutants, individual bowheads may experience multiple large and small polluting events within their lifetime.

In the Biological Opinion for Federal oil and gas leasing and exploration by the MMS within the Alaskan Beaufort Sea and its effects on the endangered bowhead whale, the NMFS (2001:51) stated that: "It is difficult to accurately predict the effects of oil on bowhead whales (or any cetacean) because of a lack of data on the metabolism of this species and because of inconclusive results of examinations of baleen whales found dead after major oil releases."

The MMS provides an extensive review and discussion of potential impacts of oil spills on endangered whales in our *Biological Evaluation of Potential Effects of Oil and Gas Activities in the Chukchi Sea and Beaufort Sea Program Areas on Bowhead, Fin and Humpback Whales*. This document is provided on our website at <http://www.mms.gov/alaska>.

The MMS concludes that there could potentially be displacement of bowhead whales from a local feeding area following a fuel spill, and this displacement could last as long as there is a large amount of oil and related cleanup-vessel activity. Individual bowhead whales potentially could be exposed to spilled fuel oil,

and this exposure could have short-term effects on health. Outside of a major fuel spill resulting from a vessel sinking, we expect seismic-survey spill-related effects to be minor.

IV.C.1.f(1)(d)8 Potential Effects of Noise and Disturbance on Fin and Humpback Whales. It cannot be ruled out that humpback or fin whales feeding north of the Chukchi Peninsula could hear noise from seismic surveys associated with exploration (especially sounds from the 2D/3D seismic surveys) in the Chukchi Sea Proposed Action area because: (1) seismic surveys could occur anywhere within the Proposed Action area; (2) we have incomplete knowledge of potential sound propagation in various locations and under specific conditions in the Chukchi Sea; and (3) seismic survey sound has been detectable hundreds and even thousands of kilometers from the source. Impacts of such noise detection, if such detection occurs at all and causes any response, are most likely to be short term and related to minor behavioral changes, if any, and to be of negligible impact to the population. The most likely potential effect, if the humpback or fin whales hear some components of the seismic noise, would be some increased attentiveness to the noise, with a potential for slight modification of their attentiveness to other sounds and possibly changes in their vocalizations.

Fin whales and humpback whales also might be exposed to the seismic-survey vessels or to the support vessels as the boats transit to the Chukchi Sea in June and return as ice conditions dictate in the autumn. As noted, survey data indicate that humpback whales leave the most southern part of the Chukchi Sea, the northern part of the Gulf of Anadyr prior to the start of ice formation (Mel'nikov, 2000). As vessels may be heading south to avoid the same ice, these vessels could overlap in time and space with the whales as both head southward. All vessels are required to comply with law that forbids a person subject to the jurisdiction of the U.S. to approach, by any means, within 100 yd (91.4 m) of a humpback whale in any waters within 200 nmi of Alaska. Vessels (with some exemptions) transiting near humpbacks also are required to adhere to a "slow, safe speed" requirement to prevent disturbance that could adversely affect humpbacks.

For the reasons given above, we conclude it is unlikely there would be adverse effects from noise and disturbance associated with oil and gas seismic-survey activities in the Chukchi Sea evaluation area on fin or humpback whales because of the distance they are expected to be from such activities. However, if humpback whales and fin whales were present, available data indicate that humpback whales are likely to be more responsive to seismic-survey noise than fin whales, and behavior disturbance could occur as with bowhead whales.

IV.C.1.f(1)(e) Conclusions. It is unlikely that there would be any adverse effects from noise and disturbance associated with seismic-survey activities in the Chukchi Sea project area on fin or humpback whales because of the distance the species will be from such activities, i.e., that they are not expected to occur in the Proposed Action area. However, if humpback whales and fin whales were on occasion to enter the Proposed Action area, available data indicate that humpback whales are likely to be more responsive to seismic-survey noise than fin whales. The most likely potential effect, if the humpback or fin whales hear some components of the seismic noise, would be some increased attentiveness to the noise, with a potential for slight modification of their attentiveness to other sounds and possibly changes in their vocalizations.

IV.C.1.f(1)(e)1 Effects from Exploration Activities. Exploration activities (e.g., drilling, vessel traffic, icebreaker use, aircraft traffic, discharges) are sources of noise and disturbance to bowhead whales, and stationary sources of offshore noise (such as drilling units) appear less disruptive to bowhead whales than moving sound sources (such as vessels). There is a paucity of information about the potential effects of exploration activities on threatened and endangered whale species in the Chukchi Sea. However, a great deal of information exists about bowhead whale reactions to drilling operations in the nearby Beaufort Sea, the majority which is applicable to the issues covered in this section and is cited accordingly.

Exploration work could begin before the lease sale to identify prospective tracts for bidding. This work is likely to include 3D seismic surveys (see Sec. IV.C.1.f(1)(d) for discussion of the potential impacts of 2D/3D and high-resolution seismic surveys) and will not include prelease exploration drilling. After the lease sale and prior to drilling deep test wells, high-resolution site-clearance seismic surveys and geotechnical studies will examine the proposed exploration drilling locations for geologic hazards and archaeological features. Site clearance and studies required for exploration will be conducted during the open-water season before a drill rig is mobilized to the site. Because of water depths >100 ft, drilling

operations are likely to employ drill-ships with icebreaker-support vessels rather than bottom-founded drilling platforms, manmade gravel islands, ice islands, or caisson-retained islands. Drilling operations typically operate at a given well site between 30-90 days, and MMS anticipates one to two exploration wells per season could be drilled between June-November.

IV.C.1.f(1)(e)1a) Potential Effects from Exploration Drilling. Drilling operations in the spring lead and polynya system during the spring bowhead migration has a fairly high potential of affecting threatened and endangered whales; however, the general location of the spring lead system is based on relatively limited survey data and is not well defined. At present, exploratory drilling in the Chukchi Sea portion of the lead system could begin in June and go through November.

Drilling for oil and gas generally produces low-frequency sounds with strong tonal components. There are few data on the noise from conventional drilling platforms. Recorded noise from an early study of one drilling platform and three combined drilling production platforms found that noise was so weak, it was almost not detectable alongside the platform at sea states of 3 or above. The strongest tones were at very low frequencies near 5 Hz, and received levels of these tones at near-field locations were 119-127 dB re 1 μ P (Richardson et al., 1995a).

The NMFS (2001) concluded that:

...bowhead whale responses to noise from drilling and exploration activities are expected to depend on the type of activity and its location relative to the whales' normal migration corridors... Thus, a drill ship operating offshore and closer to the center of the migration is expected to have a greater biological impact than a drilling operation from an artificial island situated in very shallow water along the nearshore edge of the migration.

Bowhead whale reactions to drillships are variable. Some bowhead whales 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 km (0.12-1.12 mi) to drilling from an artificial island when the signal-to-noise ratio is 30 dB. By comparison, they predicted that roughly half of the bowheads likely would respond at a distance of 1-4 km (0.62-2.5 mi) from a drillship drilling when the signal-to-noise ratio is 30 dB. A smaller proportion would react when the signal-to-noise ratio is about 20 dB (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.

Some researchers observed that bowhead whale behavior appeared normal on several occasions within 10-20 km (6.2-12.4 mi) of drillships in the eastern Beaufort Sea, and there have been a number of reports of sightings within 0.2-5 km (0.12-3 mi) from drillships (Richardson et al., 1985; Richardson and Malme, 1993). On several occasions, the bowhead whales were well within the zone where they should be able to clearly detect drillship noise. In other cases, bowheads may avoid drillships and their support vessels at 20-30 km (NMFS, 2003a,b). The factors associated with the variability are not fully identified or understood.

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. Additionally, it is not known what components of the population were observed around the drillship (adult or juvenile males, adult females, etc.).

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 1980's 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 km (14.3-16.8 mi) from the center of the drilling operation. Migrating whales apparently avoided the area within 10 km (6.2 mi) of the drillship, passing both to the north and to the south of the drillship. The study detected no bowheads within 9.5 km (5.9 mi) of the drillship, and few were observed within 15 km (9.3 mi). The principal finding of this study was that migrating bowheads appeared to avoid the offshore drilling operation in fall 1986. Thus, some bowheads may avoid noise from drillships at 20 km (12.4 mi) or more.

In other studies, Richardson, Wells, and Wursig (1985) observed three bowheads 4 km (2.48 mi) from operating drillships, well within the zones ensounded 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 km (6.2-12.4 mi) from operating drillships. On two of the occasions, drillship noise was not detectable by researchers at distances from 10-12 km (6.2-7.4 mi) and 18-19 km (11.2-11.8 mi), 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 km (0.12-3 mi) 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 broad-band source levels (10-10,000 Hz) during drilling and tripping were estimated to be 191 and 179 dB re μPa at 1 m, respectively, based on measurements at a water depth of 20 m in water about 30 m deep (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 km (12.4 mi). He 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 m (436 yd) 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); Schick and Urban 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 m (426 ft) 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-Hz band, the average source level was 166 dB re 1 μ Pa in 1990 and 165 dB re 1 μ Pa 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 μ Pa. One whale came within 110 m (360 ft) of the projector. Many whales came within 160-195 m (525-640 ft), where the received broadband (20-1,000 Hz) sound levels were about 135 dB re 1 μ Pa. That level was about 46 dB above the background ambient level in the 20- to 1,000-Hz 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.

Richardson et al. (1995b) reported that bowhead whale avoidance behavior has been observed in half of the animals when exposed to 115 dB rms re 1 μ P broad-band drillship noises. However, reactions vary depending on the whale activity, noise characteristics, and the physical situation (Richardson et al., 1995a,b).

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 km (0.62 mi). Turns were unusually frequent out to 2 km (1.25 mi), and there was evidence of subtle behavioral effects at distances up to 2-4 km (1.25-2.5 mi). 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 Hz, and quite likely at even lower frequencies. It is not known whether the under-representation of low-frequency components (<45 Hz) during icebreaker playbacks had significant effects on the responses by bowheads. Bowheads presumably can hear sounds extending well below 45 Hz. It is suspected but not confirmed that their hearing extends into the infrasonic range below 20 Hz. The authors believed the projector adequately reproduced the overall 20- to 1,000-Hz level at distances beyond 100 m (109 yd), even though components below 80 Hz were under-represented. If bowheads are no more responsive to sound components at 20-80 Hz than to those above 80 Hz, then the playbacks provided a reasonable test of the responsiveness to components of Karluk sound above 20 Hz.

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.

Brueggeman et al. (1992) conducted studies to determine the response of seals and whales to icebreaking and drilling operations at the Crackerjack and Diamond prospects in the northern Chukchi Sea between June and October 1991. Trained marine mammal observers conducted aerial surveys and vessel-based observations at each prospect throughout the drilling season. In conjunction with the aerial and vessel-based observations, acoustic measurements were made to characterize the sound levels of icebreaking activities and to monitor for the presence of bowhead whales in the prospects. Comparisons of animal use before, during, and after drilling operations were confounded by the dynamic changes in the conditions at the prospects caused by the movement and composition of the sea ice. The small proportion of whales that were briefly observed in the prospects did not show any obvious avoidance reactions.

IV.C.1.f(1)(e)1)b) Potential Effects from Icebreaking Activities. If drillships are attended by icebreakers, as typically is the case during the fall, the drillship noise frequently may be masked by icebreaker noise, which often is louder. 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 km (1.24-15.53 mi) (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 km (1.25-7.46 mi) when the sound-to-noise ratio is 30 dB. 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 km (2.86-12.4 mi) when the sound-to-noise ratio is 30 dB.

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 dB 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 dB over the frequency range 40-6,300 Hz). 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 dB 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 km (6.2-18.6 mi) and sometimes to 50+ km (31.1 mi).

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 dB around the "typical" threshold, with commensurate variability in predicted reaction radius.

Richardson et al. (1995a) reported that broadband (20-1,00 Hz) received levels at 0.37 km for the icebreaking supply vessel the *Canmar Supplier* underway in open water was 130 dB and 144 dB when it was breaking ice. The increase in noise during icebreaking is apparently due to propeller cavitation. Richardson et al. (1995a) summarized that icebreaking sound from the *Robert Lemeur* pushing on ice were detectable >50 km away. We anticipate that an icebreaker would attend a drillship in the Chukchi Sea. Brewer et al. (1993) reported that in the autumn of 1992, migrating bowhead whales avoided an icebreaker-accompanied drillship by 25+ km. This ship was icebreaking almost daily. However, Richardson et al. (1995a) noted that in 1987, bowheads also avoided another drillship with little icebreaking.

IV.C.1.f(1)(e)1)c) Potential 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. This avoidance may be related to the fact that bowheads have been commercially hunted within the lifetimes of some individuals within the population and they continue to be hunted for subsistence throughout many parts of their range. Avoidance usually begins when a rapidly approaching vessel is 1-4 km (0.62-2.5 mi) away. A few whales may react at distances from 5-7 km (3-4 mi), and a few whales may not react until the vessel is <1 km (<0.62 mi) away. Received noise levels as low as 84 dB re 1 μ Pa or 6 dB above ambient may elicit strong avoidance of an approaching vessel at a distance of 4 km (2.5 mi) (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 km (1.2-2.5 mi) and to move away at increased speeds when approached closer than 2 km (1.2 mi) (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. Data are not sufficient to determine sex, age, or reproductive characteristics of response to vessels. We are not aware of data that would allow us to determine whether females with calves tend to show avoidance and scattering at a greater, lesser, or at the same distances as other segments of the population.

The encounter rate of bowhead whales with vessels associated with exploration would be determined on what areas were being explored. 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.

In 2003 there was concern by Alaskan Native whalers that barge traffic associated with oil and gas activities might have caused bowhead whales to move farther offshore and, thus, to be less accessible to subsistence hunters. ConocoPhillips contracted with Greeneridge Sciences to determine noise propagation distances associated with the barging activities. Greene (2003) concluded that a broadband source level of 171 dB re 1 μ P at 1 m is a reasonable and potentially a conservative (higher than the likely actual source level) estimate to use as a source level for the “relatively small tug and barge used by ConocoPhillips in its demobilization activities.” After evaluating alternative models for estimating transmission loss, and considering likely ambient noise levels (based on data collected in 1996 offshore of Northstar), Greene (2003) applied the estimated source level to what he viewed as the most reasonable sound propagation loss model to estimate the received level of sound at four distances (0.1-63 km) from the tug and barge. The estimated hearing distances are based on the assumption that the whales do not hear sounds below the background noise level. Greene acknowledged that this assumption oversimplifies the hearing process but believes it is reasonable, given the approximations made for source level and for propagation loss. Greene (2003) estimated the following received sound levels at specific distances: 131 dB re 1 μ PA at 0.1 km; 111 dB re 1 μ PA at 1.0 km; 102 dB re 1 μ PA at 2.8 km; and 75 dB re 1 μ PA at 63 km. Given the assumptions that were required about hearing and the approximations regarding sound transmission loss, Greene (2003:4) stated it would be best to consider the estimates of received sound levels as “guidelines.” ConocoPhillips also evaluated traditional knowledge information available from a 1997 workshop held in Barrow (Majors, 2004, pers. commun.). Based on this information, they concluded that whales would have returned to their original headings about 45 mi before reaching Barrow if they had encountered noise from the barging operation at Camp Lonely. We cannot critically evaluate this conclusion, because it is unclear exactly which information it is based upon. ConocoPhillips and the NSB both researched the timing of vessel activities in the region. ConocoPhillips reported that this research revealed that another barge, unrelated to oil industry activities, departed Barrow for Deadhorse on October 8, 2003, which was the first day a whale was landed in Barrow (Majors, 2004, pers. commun.). They also reported that an elder Barrow whaling captain reported that migration patterns of many species were different in 2003. For example, he reported that bowhead whales were spotted on the west side of Barrow in August, 2003. On the NSB map reporting the locations of landed whales offshore of Barrow, the waters nearshore to about 20 mi offshore were recorded to be muddy. ConocoPhillips concluded that their barging operations were not the cause of deflected whales offshore of Barrow in the fall of 2003 (Majors, 2004, pers. commun.). There are no other data available to MMS regarding potential effects of the barge operations. Thus, we cannot critically evaluate the potential influence of the barging operations on whale movements near Barrow in 2003.

In addition to acting as a source of noise and disturbance, marine vessels could potentially strike bowhead whales, causing injury or death. As noted in the baseline section of this evaluation, available information indicates that current rates of vessel strikes of bowheads are low. At present, available data do not indicate that strikes of bowheads by oil and gas-related vessels will become an important source of injury or mortality. Risk of strikes would increase as vessel traffic in bowhead habitat increases.

IV.C.1.f(1)(e)1)d) Potential Effects from Aircraft Traffic. Most offshore aircraft traffic in support of the oil industry involves turbine helicopters flying along straight lines, and 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 m (500 ft). At altitudes below 150 m (500 ft), 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 m or less and lateral distances of 250 m 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 m showed that sound consisted mainly of main-rotor tones ahead of the aircraft and tail-rotor sounds behind the aircraft; more sound pressure was received at 3 m than at 18 m; and peak sound levels received underwater diminished with increasing aircraft altitude. Sound levels received underwater at 3 m from a Bell 212 flying overhead at 150 m ranged from 117-120 dB re 1 μ Pa in the 10- to 500-Hz band. Underwater sound levels at 18 m from a Bell 212 flying overhead at 150 m ranged from 112-116 dB re 1 μ Pa in the 10- to 500-Hz 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 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) 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 m. 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 m or less and lateral distances of 250 m or less. There was little, if any, reaction by bowheads when the aircraft circled at an altitude of 460 m and a radius of 1 km. The effects from an encounter with aircraft are brief, and the whales should resume their normal activities within minutes.

IV.C.1.f(1)(e)1)e Potential Effects from Discharges. There could be alterations in bowhead habitat as a result of exploration-related localized pollution and habitat destruction. Any potential adverse effects on endangered whales from discharges are directly related to whether or not any potentially harmful substances are released into the marine environment; what their fate in that environment likely is (for example, different hypothetical fates could include rapid dilution or biomagnification through the food chain); and thus, whether they are bioavailable to the species of interest.

Disposal of drilling muds and cuttings would be specified under conditions prescribed by the USEPA's NPDES permit. Discharge of drilling muds and cuttings during exploration activities is not expected to cause population-level effects, either directly through contact or indirectly by affecting prey species. Any effects would be localized primarily around the drill rig because of the rapid dilution/deposition of these materials. Exploration drilling muds and cuttings may cover portions of the seafloor and cause localized pollution. 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.

IV.C.1.f(1)(e)2 Effects of Development, Production, and Abandonment Activities. Because there are no oil and gas production facilities in the Chukchi Sea, it is difficult to predict with certainty what potential impacts from such development would have on threatened and endangered marine mammals. What is known about the potential impacts of oil and gas development and production in the Arctic Ocean is related to studies and research conducted in the Alaska and Canadian Beaufort seas, east of the Chukchi Sea Proposed Action area. Applicable findings from the foregoing research and studies are used and cited in our analyses.

Because of relatively deep water in the Chukchi Sea, no island-construction activities are expected to occur and a large bottom-founded platform is likely to be used as a central facility. Subsea wells would be completed in templates and production would be gathered to the central platform by flowlines. Subsea well templates would be located within 15 mi from the central platform. The subsea equipment and pipelines would likely be installed below the seafloor surface for protection against possible ice masses. Drilling on the platform would occur year-round, while subsea wells would be drilled by drillships during the summer open-water season. See Section IV.A.1 for a detailed description of the activities associated with oil and gas development and production, and abandonment of facilities in the Chukchi Sea Proposed Action area.

The agents likely to affect threatened and endangered marine mammals, especially the bowhead whale, in or near the Sale 193 area are industrial noise (e.g., drilling, vessel and aircraft movements) and discharges (e.g., petroleum).

IV.C.1.f(1)(e)2)a) Noise-Generating Activities and Impact Analysis.

IV.C.1.f(1)(e)2)b) Drilling Operations from Bottom-Founded Structures. To date, only two types structures have been used for offshore drilling in the Arctic Ocean, and both were drilled 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 single 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 begins 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 are low (frequencies above 30 Hz). The overall received level is around 109 dB re 1 μ Pa at 278 m, excluding any infrasonic components. When the concrete island drilling system is drilling in early winter, radiated sound levels above 30 Hz again are relatively low (89 dB at 1.4 km). However, when infrasonic components are included, the received level is approximately 112 dB at 1.4 km. More than 99% of the sound energy received is below 20 Hz. Received sound levels at a distance of 222- to 259-m range from 121 to 124 dB. The maximum detection distance for infrasonic sounds has not been determined. Such tones likely would attenuate rapidly in shallow water. Overall, the estimated source levels are low for the concrete island drilling system, even when the infrasonic tones were included (Richardson et al., 1995a).

Richardson et al. (1995a) reported that sounds from a steel drilling caisson were measured during drilling operations in water 15 m deep with 100% ice cover. The strongest underwater tone was at 5 Hz (119 dB re μ Pa) at a distance of 115 m. The 5-Hz tone apparently was not detectable at 715 m, but weak tones were present at 150-600 Hz. The broadband (20-1,000 Hz) received level at 215-315 m was 116-117 dB re μ Pa, higher than the 109 dB reported for the concrete island drilling system at 278 m.

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 whale migration corridor and about the noise generated from a steel drilling caisson. However, information provided during the comment period of the draft EIS found that Inupiat hunters also are concerned about other types of anthropogenic noise generated by the oil and gas and other industries. See Section IV.C.1.I for a detailed description of potential impacts of oil and gas development, production, and abandonment activities on subsistence activities in the Chukchi Sea area.

IV.C.1.f(1)(e)2)c) Development and Production. Development and production activities likely would involve the intermittent use of supply vessels and helicopters. Production operations in the sale area would not be limited by ice conditions, would continue year-round and, hence, would occur during both the spring and fall bowhead migrations. The actual rate of bowhead whales encountering production noise would vary depending on the number of whales in the bowhead population, the number of production operations per year, annual ice conditions, and unknown factors associated with migratory-path selection within the greater fall migration corridor.

As noted in the Beaufort Sea multiple-sale final EIS (USDOJ, MMS, 2003a), it has been documented that bowhead and other whales avoid various industrial activities if the received sound levels associated with the activity are sufficiently strong (see summaries and references in Richardson et al., 1995a and NRC, 2003). The only known monitoring study in the Alaska Arctic Ocean of sound associated with offshore oil and gas construction and production activities and the monitoring of marine mammals in nearby area occurred at the BPXA Northstar facility, which was constructed on the remnants of a submerged artificial gravel island in the Beaufort Sea called Seal Island. To date, it is the only offshore oil production facility north of the barrier islands in the Alaska Arctic Ocean and it provided information relative to assessing potential impacts of oil and gas production-related noise on bowhead whales (Williams and Rodrigues, 2003).

Richardson and Williams (2003, 2004) summarized studies conducted during the open-water period to determine both the underwater noise levels at various distances north of Northstar facility and potential impacts on bowhead whales north of the island, as assessed by locations determined by vocalization locations. Blackwell and Greene (2004) found that in the absence of boats and during the construction,

drilling, and production phases, island sounds reached background values at distances of 2-4 km in quiet ambient conditions. Blackwell and Greene (2004) also concluded that during the open water season, vessels such as self-propelled barges, crew boats, and tugs were the primary contributors to the underwater sound field. Richardson and Williams (2003) and Blackwell (2003) summarized that when both oil production and drilling was occurring, underwater and airborne sound reached background levels at about 3.5 km (2.2 mi.) from Northstar in quiet ambient conditions.

Data from monitoring programs of the Northstar facility from November 2004 to October 2005 found a “statistically significant, but small deflection effect in the southern part of the bowhead migration route offshore of Northstar (west of Cross Island) at times when noise from Northstar was at its highest levels” (McDonald et al., 2006). However, the latest annual report from the Northstar monitoring program (see Richardson, 2006) found that although noise and oil spills still are a concern to whalers, they have not reported any impacts to their whaling activities from the presence of the Northstar facility. Some whalers reported avoided close approaches to the facility. Overall, the available data on bowhead locations, coupled with data on noise propagation, indicate that if noise from Northstar is having an impact on whale movements, the effect, if it exists, is not dramatic.

IV.C.1.f(1)(e)2)d Vessel and Aircraft Traffic. The potential impacts associated with development-, production-, and abandonment-related aircraft and vessel traffic (including icebreaker activities) are similar to those potential aircraft and vessel traffic impacts associated with exploration activities (e.g. seismic surveys) (see Sec. IV.C.1.f(1)(c), Potential Effects of Seismic Surveys). Bowhead, fin, and humpback whales could be disturbed by noise and vessel traffic, but the frequency (trips/week) and location of disturbance would be different for exploration and production activities. For exploration, trips would be frequent but to different scattered sites. For ongoing production operations, trips would be less frequent but to the same site. The most intense traffic would occur during development/construction with frequent trips to the same site; however, this activity would only last a few years. In contrast, production operations would span decades.

IV.C.1.f(1)(e)2)e Abandonment. Other potential sources of noise, disturbance, and possible injury to threatened and endangered species during OCS oil and gas activities are associated with abandonment operations. Abandonment operations include plugging and abandoning wells, decommissioning subsea pipelines, and removal of production equipment and platforms. There are established procedures and regulations for all of these abandonment operations. Wells usually are permanently plugged with cement after the wellhead equipment is removed. The casings for delineation wells usually are cut mechanically or with small explosive charges. Well-plugging operations could occur at different times, depending on whether the wells are on- or off-platform. Off-platform wells (exploration or subsea production wells) are likely to be plugged and abandoned in the summer open-water season using marine vessels. On-platform wells (normal production wells) could be plugged and abandoned at any time. The use of explosives could result in injury or even death to threatened and endangered marine mammals in the area at the time of the explosions, although the threshold levels for injury or death are not well established (Ketten, Lien, and Todd, 1993; Richardson et al., 1995a,b). With respect to the abandonment of off-platform well abandonment, the MMS (USDOI, MMS, Pacific OCS Region, 2001) previously summarized that:

...the use of explosives for delineation well abandonment would involve the detonation of a relatively small, 16- to 20-kilogram charge in the well casing 5 meters below the sea floor. This positioning of the charge would dampen the explosion and restrict shock and acoustic effects primarily to the area of water immediately above the well head. However, a marine mammal close to the detonation site potentially could be injured or killed, or suffer permanent or temporary hearing damage. Some disturbance of marine mammals present in the vicinity of the detonation area could also occur, but these would be expected to be minor and temporary...Overall, impacts from this source are expected to be low.

Bowheads are the only threatened and endangered species under the jurisdiction of NMFS that regularly occurs in areas where such well-abandonment activities potentially could take place. Available data indicate that humpback whales and fin whales are unlikely to occur within the Proposed Action Area or to occur close enough to be adversely affected by well abandonment.

Impacts to bowhead whales from well-abandonment activities could be avoided entirely if these activities were implemented only when bowheads were absent. This mitigation could involve sufficient monitoring (e.g., aerial surveys and passive acoustic monitoring) for bowheads prior to the use of explosives or if protocols for mechanical methods were implemented in situations where bowhead whales were close to areas where they could be adversely impacted by the use of explosives.

Pipelines are flushed/cleaned and then usually left in place buried below the seafloor surface. Production equipment would be partly disassembled and then moved off the platform during the summer open-water season. If a decision to move the platform is made, this operation also would occur in the summer-open water season.

IV.C.1.f(1)(f) Discharge of Drilling Wastes. Any potential adverse effects on threatened and endangered marine mammals from discharges are directly related to whether or not any potentially harmful substances are released, if they are released to the marine environment, what their fate in that environment likely is (for example, different hypothetical fates could include rapid dilution or biomagnification through the food chain), and thus whether they are bioavailable to the species of interest.

Disposal of drilling muds and cuttings would be as specified under conditions prescribed by the USEPA's NPDES permit, so as not to have environmental consequences. In most cases, drilling mud is recycled in the development drilling program. All waste products (e.g. drilling mud, rock cuttings, and produced water) for on-platform wells are treated and then disposed of in shallow wells on the production platform. For the surrounding subsea wells, drilling waste products could be barged to a coastal facility for treatment and disposal. Drilling muds and cuttings may cover portions of the seafloor and cause localized pollution; however, the effects likely would be negligible because bowhead whales feed primarily on pelagic zooplankton and the areas of the sea bottom that are impacted would be inconsequential in relation to the available habitat. For the aforementioned reasons, the discharge of drilling wastes (per regulation requirements) is not expected to adversely impact threatened and endangered marine mammals.

IV.C.1.f(1)(g) Large Crude Oil Spills (greater than or equal to 1,000 barrels). Of primary concern is the potential impact of large crude oil spills $\geq 1,000$ bbl from production activities on threatened and endangered marine mammals. Studies concerning the effect of petroleum on whales, especially threatened and endangered marine mammals have focused on the effect of oil contact, ingestion or inhalation of toxic substances, blowhole and/or baleen fouling, contamination or reduction of food resources and bioaccumulation, and possible changes in behavior or distribution of whale populations in response to oil industrial activities.

Bowhead whales are the most likely of ESA-listed baleen whales to be impacted if an oil spill occurred in the Chukchi Sea Proposed Action area because they commonly occur seasonally in areas where such spills could occur. Bowhead whales use portions of the Chukchi Sea for spring and fall migration, feeding, calving, resting, and limited breeding. Most of the calving for this population probably occurs between the Bering Strait and Point Barrow. Thus, they could be exposed to freshly spilled oil and its high levels of toxic aromatic compounds, as well as to oil that is spilled at some distance and that moves into areas inhabited by whales.

IV.C.1.f(1)(g)1 General Information about the Potential Effects of Oil on Marine Mammals.

Although there is no conclusive evidence that large baleen whales would be killed as a result of contact with spilled oil, the mammalian literature indicates that adult whales could die from prolonged exposure to oil. It is well documented that exposure of at least some mammals to petroleum hydrocarbons through surface contact, ingestion, and especially inhalation can be harmful. Surface contact with petroleum hydrocarbons, particularly the low-molecular-weight fractions, can cause temporary or permanent damage of the mucous membranes and eyes (Davis, Schafer, and Bell, 1960) or epidermis (Hansbrough et al., 1985; St. Aubin, 1988; Walsh et al., 1974). Contact with crude oil can damage eyes (Davis, Schafer, and Bell, 1960). Corneal ulcers and abrasions, conjunctivitis, and swollen nictitating membranes were observed in captive ringed seals placed in crude oil-covered water (Geraci and Smith, 1976), and in seals in the Antarctic after an oil spill (Lillie, 1954). Corneal ulcers and scarring were observed in otters captured in oiled areas (Monnett and Rotterman, 1989) and in oiled otters brought into oil-spill treatment centers (Wilson et al., 1990) after the EVOS. Ingestion of petroleum hydrocarbons can lead to subtle and progressive organ damage or to rapid death. Inhalation of volatile hydrocarbon fractions of fresh crude oil

can damage the respiratory system (Hansen, 1985; Neff, 1990), cause neurological disorders or liver damage (Geraci and St. Aubin, 1982), have anaesthetic effects (Neff, 1990) and, if accompanied by excessive adrenalin release, cause sudden death (Geraci, 1988).

Many PAH's are teratogenic and embryotoxic in at least some mammals (Khan et al., 1987). Maternal exposure to crude oil during pregnancy may negatively impact the birth weight of young. After seals were experimentally dosed with crude oil, increased gastrointestinal motility and vocalization and decreased sleep were observed (Geraci and Smith, 1976; Engelhardt, 1985, 1987). Oil ingestion can decrease food assimilation of prey eaten (St. Aubin, 1988). Decreased food assimilation could be particularly important in very young animals, those that seasonally feed, and those that need to put on high levels of fat to survive their environment.

There are few post-spill studies with sufficient details to reach firm conclusions about the effects, especially the long-term effects, of an oil spill on free-ranging populations of marine mammals. However, available evidence suggests that mammalian species vary in their vulnerability to short-term damage from surface contact with oil and ingestion. While differences in acute vulnerability to oil contamination do exist due to ecological (for example, nearshore versus offshore habitat) and physiological reasons (e.g., dependence on fur rather than on blubber for thermal protection), species also vary greatly in the amount of information that has been collected about them and about their potential oil vulnerability. These facts are linked, because the most vulnerable species have received the most focused studies. However, it also is the case that it is more difficult to obtain detailed information on the health, development, reproduction and survival of large cetaceans than on some other marine mammals. Data are not available that would permit evaluation of the potential for long-term sublethal effects on large cetaceans. Marine mammals also can be affected indirectly after a spill due to oil and cleanup disturbance and damage to prey resources. Both short- and long-term effects potentially can occur from increased boat and aircraft traffic associated with spills. Longer term oil contamination of food sources, changes in distribution of prey species, decreased productivity/abundance of prey species, and localized mortality of prey species of various high trophic-level marine mammals can further concentrate contaminants.

IV.C.1.f(1)(g)2 Observations of Cetaceans after Large and Catastrophic Oil Spills. If mortality of bowheads were to occur after exposure to fresh crude oil after a large spill, it would not be consistent with many, perhaps most, published findings of impacts of oil on cetaceans after real oil spills. However, as pointed out in the Cook Inlet multiple-sale final EIS (USDOJ, MMS, 2003b), information about environmental impacts on whales is rudimentary and full of speculation and uncertainty. While animals such as sea otters, seals, and many birds can be examined closely, impacts on whales from oil spills (and many other perturbations) are difficult to assess because large numbers of most of the species cannot be easily captured, examined, weighed, sampled, or monitored closely for extended periods of time. Thus, impacts such as the sublethal impacts observed on sea otters (for example, reduced body condition, abnormal health, etc.) (Rotterman and Monnett, 2002, and references cited therein) after the EVOS are unlikely to be documented in cetaceans because the data needed to determine whether or not such impacts exist cannot be collected. On the other hand, it may be that ecological and physiological characteristics specific to large cetaceans serve to buffer them from many of those same types of impacts. Unless impacts are large and whales die and are necropsied, most effects must be measurable primarily using tools of observation. Unless baseline data are exceptionally good, determination of an effect is only possible if the effect is dramatic. With whales, even when unusual changes in abundance occur following an event such as the EVOS (as with the disappearance of relatively large numbers of killer whales from the AB pod in Prince William Sound) (Dahlheim and Matkin, 1994), interpretation of the data is uncertain or is often controversial due to the lack of supporting data, such as oiled bodies or observations of individuals in distress (and, in that case, the existence of a viable alternate explanation of the probable mortality). Thus, the potential for there to be long-term sublethal (for example, reduced body condition, poorer health, or longer dependency periods), or lethal effects from a large oil spill on cetaceans essentially is unknown. There are no data on cetaceans adequate to evaluate the probability of such effects.

Loughlin (1994) observed gray whales swimming in oil from the EVOS in March 1989, but no gross abnormalities were reported. J. Lentfer (as reported in Harvey and Dahlheim, 1994) reported seeing three gray whales at the southwest entrance to Prince William Sound swimming northwest through a moderate amount of oil. Based on 10 minutes of observation, J. Lentfer (cited in Harvey and Dahlheim, 1994) reported that the whales continually swam at the surface and appeared lethargic. After the EVOS, Loughlin

(1994) reported that 26 gray whales were found in 1989 on Alaska beaches from Kayak Island to King Salmon and other whales were reported at Sitkinak Island and Tugidak. Loughlin (1994) concluded that the reason for the greater number of whales found is unexplained but may be attributable to the fact that the search after the EVOS coincided with the northern migration of gray whales and to the greater activity in remote areas after the spill. Blubber samples from three gray whales, two minke whales, and five harbor porpoise contained polycyclic aromatic hydrocarbons with a profile consistent with a petrogenic source (Loughlin, 1994). Loughlin (1994) reported that histological examination of all tissues were unremarkable and provided no information about the cause of death of any of the cetaceans.

After the EVOS, Harvey and Dahlheim (1994) observed groups of Dall's porpoises on 21 occasions in oiled areas. One Dall's porpoise had oil on the dorsal half of its body and appeared stressed because of its labored breathing pattern. Harvey and Dahlheim (1994) report that the dorsal surface of the porpoise's body, from the blowhole to the dorsal fin, was covered in oil. Lung problems were common in oiled otters brought into treatment centers after the EVOS and are frequent in mammals following inhalation of petroleum hydrocarbons.

After the EVOS, von Ziegesar, Miller, and Dahlheim (1994) stated that potential (but not documented) impacts to the humpback whale, from the EVOS included displacement from normal feeding areas, reduction in prey, or possible physiological impacts resulting in mortality or reproductive failure. von Ziegesar, Miller, and Dahlheim (1994) reported that no humpbacks were observed feeding in water with floating oil but were seen in areas that comprised the primary path of the spill. However, most of the still floating oil had exited the sound prior to peak humpback abundance. However, considerable oil remained and oil continued to wash off of beaches due to wave action and oil-spill-cleanup activities. Whales also were exposed to increased noise and other disturbance due to oil-spill cleanup. von Ziegesar, Miller, and Dahlheim (1994) report that no humpbacks were observed swimming in oil and no humpback deaths or strandings were reported during 1988-1990 in Prince William Sound. They concluded that the results of their study do not indicate a change in calving rate, seasonal residence time, mortality, or abundance. They concluded also that long-term impacts to the whales or their environment could not have been detected in the short period of their study, and that because of the wide distribution of humpback whales in the North Pacific and unequal surveying effort in their study, the effects, if any, of the EVOS on humpbacks may never be known.

Neither mysticete nor odontocete whales seem to consistently avoid oil, although they can detect it (Geraci, 1990). Geraci (1990) reported that fin whales, humpbacks, dolphins and other cetaceans have been observed entering oiled areas and behaving normally. Geraci (1990) summarized available information about the physiological and toxic impacts of oil on cetaceans. He concluded that although there have been numerous observations of cetaceans in oil after oil spills, there were no certain deleterious impacts. To date, no bowhead whale deaths resulting from an oil spill have been document and reported.

IV.C.1.f(1)(g)3 Potential Effects of a Large Oil Spill on Bowhead Whales. Following a large oil spill, bowhead or other baleen whales could suffer adverse effects due to:

- inhalation of toxic components of crude oil;
- ingesting oil and/or contaminated prey;
- fouling of their baleen;
- oiling of skin, eyes, and conjunctive membranes causing ;
- reduced food source; and
- displacement from feeding areas.

IV.C.1.f(1)(g)3a Inhalation of Toxic Components of Crude Oil. The greatest threat to large cetaceans probably is from inhalation of volatile compounds present in fresh crude oil. Based on literature on other mammals indicating severe adverse effects of inhalation of the toxic aromatic components of fresh oil, mortality of bowheads or other cetaceans could occur if they surfaced in large quantities of fresh oil. Bowhead calves would be especially vulnerable to fumes from a large spill because they take more breaths than do their mothers and spend more time at the surface. Thus, it is likely they would be more likely to succumb to inhalation of toxic aromatic compounds. Inhalation of volatile hydrocarbon fractions of fresh crude oil can damage the respiratory system (Hansen, 1985; Neff, 1990), cause neurological disorders or

liver damage (Geraci and St. Aubin, 1982), have anesthetic effects (Neff, 1990) and, if accompanied by excessive adrenalin release, cause sudden death (Geraci, 1988).

The potential for there to be long-term sublethal (for example, reduced body condition, poorer health, reduced immune function, reduced reproduction or longer dependency periods) effects on large cetaceans from a large oil spill is essentially unknown. There are no data on large cetaceans adequate to evaluate the probability of sublethal effects.

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 damage. Fraker (1984) 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 weathered oils would not be expected to suffer serious consequences 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. Within hours after the spill, toxic vapors from oil in a lead could harm the whales' lungs and even kill them. The number of whales affected would depend on how large the spill was, its behavior after being spilled, and how many whales were present in areas contacted in the first several days following the spill.

IV.C.1.f(1)(g)3)b) Direct Contact of Skin and other Surfaces with Spilled Oil. The effects of oil contacting skin are largely speculative, as there is no information about how long spilled oil will adhere to the skin of a free-ranging whale. It might be possible that oil will wash off the skin and body surface shortly after bowheads vacate oiled areas; however, oil might adhere to the skin and other surface features (such as sensory hairs) longer if bowheads remained in or left the oiled area.

Bowhead whale and other marine mammal eyes may be vulnerable to damage from crude oil on the water due to their eye's unusual anatomical structure (Davis, Schafer, and Bell, 1960). Corneal ulcers and abrasions, conjunctivitis, and swollen nictitating membranes were observed in captive ringed seals placed in crude oil-covered water (Geraci and Smith, 1976), and in seals in the Antarctic after an oil spill (Lillie, 1954). Corneal ulcers and scarring were observed in otters captured in oiled areas (Monnett and Rotterman, 1989) and in oiled otters brought into oil-spill treatment centers (Wilson et al., 1990) after the EVOS.

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 EVOS, and they confirmed that 12 animals in light sheen or moderate-to-heavy oil did not have oil on their skin. One Dall's porpoise, which had oil on the dorsal half of its body, appeared stressed because of its labored breathing pattern. None of the observed cetaceans appeared to alter their behaviors when in oiled areas and the authors concluded their observations were consistent with other reports of cetaceans behaving normally when oil is present.

Histological data and ultrastructural studies by Geraci and St. Aubin (1990) showed that exposures of skin to crude oil for up to 45 minutes in four species of toothed whales had no effect and they concluded that a cetacean's skin is an effective barrier to the noxious substances in petroleum. Geraci and St. Aubin also investigated how oil might affect healing of superficial wounds in a bottlenose dolphin's skin and concluded that dead tissue protects underlying tissues from gasoline in the same way it repels osmotic attack by seawater. The authors further concluded that in natural conditions, contact with oil would be less harmful to cetaceans than they and others had proposed.

It is not clear how long crude oil would remain on a free-ranging cetacean's skin once it was oiled. Bratton et al. (1993) synthesized studies on the potential effects of contaminants on bowhead whales and they concluded that no published data proved oil fouling of the skin of any free-living whales and that bowhead whales contacting fresh or weathered petroleum is unlikely to suffer harm. Albert (1981) suggested 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) and that eroded skin may provide a point of entry into the bloodstream for pathogenic bacteria, if the skin becomes more damaged.

The potential effect of crude oil on the function of the cetacean blowhole is unknown. As noted, a Dall's porpoise was observed after the EVOS with crude oil covering its skin and blowhole. This individual was described as having labored breathing. Other porpoise swimming in the same area in oil did not appear to be oiled or to have abnormal behavior (Harvey and Dahlheim, 1994).

IV.C.1.f(1)(g)3)c) Ingestion of Spilled Oil. Ingestion of petroleum hydrocarbons can lead to subtle and progressive organ damage or to rapid death, as many polycyclic aromatic hydrocarbons are teratogenic and embryotoxic in at least some mammals (Khan et al., 1987). Maternal exposure to crude oil during pregnancy may negatively impact birth weight and health of young in at least some mammals (Khan et al., 1987; Currie et al., 1970). In at least some marine mammals, digestion and behavior is affected with decrease food assimilation of prey eaten (St. Aubin, 1988), increased gastrointestinal motility, increased vocalization, and decreased sleep (Geraci and Smith, 1976; Engelhardt, 1985, 1987).

Bowheads sometimes skim the water surface while feeding, filtering a lot of water for extended periods. 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. There is great uncertainty about the potential effects of ingestion of spilled oil on bowheads, especially on bowhead calves. Decreased food assimilation could be particularly important in very young animals, those that seasonally feed, and those that need to put on high levels of fat to survive their environment.

Bowheads may swallow some oil-contaminated prey, but it likely would be only a small part of their food. It is not known if bowheads would leave a feeding area where prey was abundant following a spill. Some zooplankton eaten by bowheads consume oil particles and bioaccumulation can result (see section on Potential Effects on Food Source below). 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 certain petroleum hydrocarbons.

Baleen Fouling. If a bowhead encountered spilled oil, baleen hairs might be fouled, which would reduce a whale's filtration efficiency during feeding. Lambertsen et al. (2005) concluded that the current state of knowledge of how oil would affect the function of the mouth of right whales and bowheads can be considered poor, despite considerable past research on the effects of oil on cetaceans. Lambertsen et al. (2005) believe that the resistance of the baleen is significantly increased by oil fouling and that the most likely adverse effect would be a substantial reduction in capture of larger, more actively mobile species, that is euphausiids, with possible reductions in capture of copepods and other prey. They also concluded that their results highlight the uncertainty about how rapidly oil would depurate at the near zero temperatures of arctic waters and whether baleen function would be restored after oiling.

Earlier studies on baleen fouling were summarized by Geraci (1990) who, with colleagues, had also undertaken studies of the effects of oil on baleen function. Geraci (1990) noted that while there was a great deal of interest in the possibility that residues of oil may adhere to baleen plates so as to block the flow of water and interfere with feeding, the concerns are largely speculative. He also noted that effects may be imperceptible, though leading to subtle, long-term consequences to the affected animal, and concluded that a safe assumption is that any substance in seawater which alters the characteristics of the plates, the integrity of the hairs, or the porosity of the sieve may jeopardize the nutritional well-being of the animal.

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.

Geraci (1990) summarized studies by Geraci and St. Aubin (1982, 1985) where the effects of contamination by different kinds of oil on humpback, sei, fin, and gray whale baleen were tested in saltwater ranging from 0 to 20 °C. In these studies, resistance to flow of some humpback baleen was increased more than 100%, less than 75% in gray and sei whale baleen, and gray whale samples were “relatively unaffected” (Geraci, 1990:186). Resistance to water flow through baleen was increased the greatest with contamination by Bunker C oil at the coldest temperatures. He summarized that oil of medium weight had little effect on resistance to water flow at any temperature. 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.

In the study in which baleen from fin, sei, humpback, and gray whales was oiled, Geraci and St. Aubin (1985) found that 70% of the oil adhering to baleen plates was lost within 30 minutes (Geraci, 1990) and 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. The baleen from these whales is shorter and coarser than that of bowhead whales, whose longer baleen has many hairlike filaments. Geraci (1990:187) concluded that:

Combined evidence...suggests that a spill of heavy oil, or residual patches of weathered oil, could interfere with the feeding efficiency of the fouled plates for several days at least. Effects would likely be cumulative in an animal feeding in a region so blanketed by weathered oil that the rate of cleansing is outpaced by fouling. That condition could describe the heart of a spill, or a contaminated bay or lead.

Lighter oil should result in less interference with feeding efficiency. Lambertsen et al. (2005:350) concluded that results of their studies indicate that Geraci’s analysis of physiologic effects of oiling on mysticete baleen “considered baleen function to be powered solely by hydraulic pressure,” a perspective they characterized as a “gross oversimplification of the relevant physiology.”

A reduction in food caught in the baleen could have an adverse affect on the body condition and health of affected whales. If such an effect lasted for 30 days, as suggested by the experiments of Braithwaite (1983), this could potentially be an effect that lasted a substantial proportion of the period that bowheads spend on the summer feeding grounds. Repeated baleen fouling over a long time, however, might also reduce food intake and blubber deposition, which could harm the bowheads. As pointed out by Geraci (1990), the greatest potential for adverse effects to bowheads would be if a spill occurred in the spring lead system.

Food Source. An oil spill probably would not permanently affect zooplankton populations, the bowhead’s major food source, and major 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).

The potential effects to bowheads of exposure to PAC’s through their food are unknown. Because of their extreme longevity, bowheads are vulnerable to incremental long-term accumulation of pollutants. With increasing development within their range and long-distance transport of other pollutants, individual bowheads may experience multiple large and small polluting events within their lifetime.

Duesterloh, Short, and Barron (2002) indicated that aqueous PAC dissolved from weathered Alaska North Slope crude oil are phototoxic to subarctic marine copepods at PAC concentrations that would likely result from an oil spill and at ultra violet (UV) levels that are encountered in nature. *Calanus marshallae* exposed to UV in natural sunlight and low doses [~2 micrograms (µg) of total powdered activated carbon per liter (PAC/L)] of the water soluble fraction of weathered North Slope crude oil for 24 hours) showed an 80-100% morbidity and mortality as compared to less than 10% with exposure to the oil-only or sun-light only treatments. One-hundred percent mortality occurred in *Metridia okhotensis* with the oil and UV treatment, while only 5% mortality occurred with the oil treatment alone. Duesterloh, Short, and Barron (2002)

reported that phototoxic concentrations to some copepod species were lower by a factor of 23 to >4,000 than the lethal concentrations of total PAC alone (0.05-9.4 mg/L).

This research also indicated that copepods may passively accumulate PAC's from water and could thereby serve as a conduit for the transfer of PAC to higher trophic level consumers. Bioaccumulation factors were ~2,000 for *M. okhotensis* and about ~8,000 for *C. marshallae*. *Calanus* and *Neocalanus* copepods have relatively higher bioaccumulation than many other species of copepods because of their characteristically high lipid content. The authors concluded that phototoxic effects on copepods could conceivably cause ecosystem disruptions that have not been accounted for in traditional oil spill damage assessments. Particularly in nearshore habitats where vertical migration of copepods is inhibited due to shallow depths and geographical enclosure, phototoxicity could cause mass mortality in the local plankton population. (Duesterloh, Short, and Barron, 2002).

Displacement from Feeding Areas. There is a paucity of information about whether bowhead whales may be temporarily displaced from areas affected by an oil spill or cleanup operations. However, Thomas Brower, Sr. (1980) described the effects on bowhead whales from a 25,000-gallon (595-bbl) oil spill at Elson Lagoon (Plover Islands) in 1944. It took approximately 4 years for the oil to disappear, and 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 would normally move closer to these islands during the fall migration. These observations indicate that some displacement of whales may occur in the 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.

Several other investigators have observed various cetaceans in spilled oil, including fin whales, humpback whales, gray whales, dolphins, and pilot whales. Typically, the whales did not avoid slicks but swam through them, apparently showing no reaction to the oil. For example, 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 were also observed swimming, playing, and feeding in and near the slicks, and no difference in behavior was observed between cetaceans within the slick and those beyond it. Some researchers have concluded that baleen whales have such good surface vision that they rely on visual clues for orientation in various activities.

After the EVOS, 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.

Cleanup operations following a large oil spill would be expected to involve multiple marine vessels operating in the spill area for extended periods of time, perhaps over multiple years. Based on information provided in the discussion of impacts associated with 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 km (0.62-2.5 mi) away. A few whales may react at distances from 5-7 km (3-4 mi).

After a large spill, there are typically overflights using helicopters and fixed-winged aircraft to track the spill and to determine distributions of wildlife that may be at risk from the spill. Most bowheads are unlikely to react significantly to occasional single passes by helicopters flying at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some bowheads probably would dive quickly in response to the aircraft noise (Richardson and Malme, 1993; Patenaude et al., 1997) and may have shortened surface time (Patenaude et al., 1997). Bowhead reactions to a single helicopter flying overhead probably are temporary (Richardson et al., 1995a). Whales should resume their normal activities within minutes. Fixed-wing aircraft flying at low altitude often cause hasty dives. Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) sometimes caused

abrupt turns and hasty dives (Richardson and Malme, 1993). The effects from an encounter with aircraft are brief, and the whales should resume their normal activities within minutes.

Based on all of the above information, there could potentially be displacement of bowhead whales from a feeding area following a large spill and this displacement could last as long as there is a large amount of oil and related clean-up vessels present.

IV.C.1.f(1)(g)4 Extraordinary Circumstances. The number of bowhead or other 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. Bowhead whales may be particularly vulnerable to oil-spill effects due to their use of ice edges and leads where spilled oil may accumulate (Engelhardt, 1987). Primarily because of the uniqueness of the bowhead and its apparently obligate use of spring lead and polynyas as its migratory path between wintering and summering grounds, MMS is uncertain of the potential severity of impact should a large oil spill occur within such a system, especially if spring migration were underway and hundreds of females were calving in or near those leads.

There are two situations in which bowheads are at particular risk in the event of a large oil spill. The first situation would be if a large spill occurred while the whales were migrating north through the Chukchi Sea spring lead and polynya system, particularly during the period when large numbers of females are calving or accompanied by very young calves. The effects of an oil spill on cetacean newborns or other calves and the potential effects of contact or detection of spilled oil by near-term, or post-partum females are not known. The migration path through the Chukchi Sea is relatively constrained, the area appears to be the, or a, primary calving ground of the BCB stock, and it must be assumed that essentially the whole stock needs to make this migration in order to get to summering grounds.

The potential for there to be adverse effects would also likely be greater (than in more typical circumstances) if a large spill of fresh oil (with high concentrations of aromatics) contacted one or more large aggregation of bowheads especially (but not exclusively) if such an aggregation contained large numbers of females and calves. Such aggregations occasionally have been documented in MMS aerial bowhead whale surveys. For example, Treacy (1998) observed large feeding aggregations, including relatively large numbers of calves (for example, groups of 77[6], 62[5], 57[7], and 51[0], where the numbers given in brackets are the numbers of calves) of feeding bowheads in waters off of Dease Inlet/Smith Bay in 1997 and in 1998. However, in some years no large aggregations of bowheads were seen anywhere within the study area. When seen, the aggregations were in open water. The likelihood of a large spill occurring and contacting such a group is low but not outside the range of possibilities. The factors associated with the presence of such groups are not yet clear. It is not known if they would leave the area heavily contaminated with crude oil.

IV.C.1.f(1)(g)5 Oil-Spill-Response Activities. An industry consortium stockpiles response equipment in the Prudhoe area for all three operating seasons in the Arctic: solid ice, open water, and broken ice (USDOI, MMS, 2003a:Sec. IV.A.6). For the solid-ice season, spill-response demonstrations have shown that there are effective tactics and equipment for oil recovery. For the open-water season, the effectiveness of spill-response equipment is similar to that for other OCS areas. For the broken-ice season, the Beaufort Sea multiple-sale EIS explained that research was ongoing. Recent spill demonstrations and drills have shown that the mechanical effectiveness of response equipment still is reduced greatly by broken ice. Nonmechanical response tactics (e.g., in situ burning) would be applied during these conditions.

IV.C.1.f(1)(g)5a) Probabilities of Contacting an Oil Spill. Variability in the distribution of bowhead whales in the Beaufort Sea over time and among years, and lack of recent data on bowhead seasonal distribution and abundance in the Chukchi Sea makes attempts to quantitatively model the numbers of whales that might be contacted by oil problematic. Whether, and how many, bowhead whales would come into contact with oil would depend on the location, timing, and magnitude of the spill; the location of whales when the spill occurred and over time following the spill; weather at the time of the spill; the presence and extent of shorefast and broken ice; the effectiveness of cleanup and possibly hazing activities; the motivation of the whales to get to where they were going or to stay where they were; and their options for alternate routes to their destinations (e.g., whether or not they were in leads adjacent to pack ice).

Probably the greatest potential for a large number of whales to contact spilled oil would be if there was an oil spill in the spring lead system, or if an oil spill occurred when whales were aggregated in large feeding groups.

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 necessarily 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. They did not address potential impacts within lead systems or potential effects on calves or females with calves.

IV.C.1.f(1)(g)5)b) Oil-Spill-Occurrence Estimates. The MMS previously provided oil spill analyses to NMFS in Section IV and Appendix C of the Final EIS for Chukchi Sea Oil and Gas Lease Sale 126 (USDOJ, MMS, 1990a). However, these analyses are now over 15 years old and new information is available. Should development and production occur in the Chukchi Sea OCS, the estimated chance of one or more large spills occurring is 40% over the production life. Oil spilled in portions of the Chukchi Sea OCS could contact resources in the Beaufort Sea OCS, and vice versa. The estimated chance of one or more 1,000-bbl spills occurring in the Beaufort Sea OCS is 10-11%. The estimated chance of one or more large pipeline spills is 26%, and the estimated chance of one or more large platform spills is 19% over the life of Sale 193 production. The total is the sum of the platform, wells, and pipeline spills. Thus, it is estimated that the chance of one or more large spills in the Chukchi Sea OCS is 40% over the production life.

IV.C.1.f(1)(g)6) Potential Effects of a Large Oil Spill on Fin Whales and Humpback Whales. For the reasons discussed in the aforementioned sections, it is difficult to predict the impact of a large spill on either humpback whales or especially on fin whales. Based on literature on other mammals indicating severe adverse effects of inhalation of the toxic aromatic components of fresh oil, mortality of cetaceans could occur if they surfaced in large quantities of fresh oil. However, if such mortality occurred, it would not be consistent with many, perhaps most, published findings of expected impacts of oil on cetaceans. The potential for there to be long-term sublethal (for example, reduced body condition, poorer health, or longer dependency periods), or lethal effects from large oil spill on cetaceans essentially is unknown. There are no data on cetaceans adequate to evaluate the probability of such effects.

Because of their limited distribution, the primary potential adverse effect on fin whales from oil and gas development would be from a large oil spill that contacted waters adjacent to the Chukchi Peninsula in the southwestern Chukchi Sea. Data, however, do not indicate that fin whales were adversely affected by the EVOS, which was many times larger than the spill range we analyze here, or by the *Glacier Bay* oil spill.

Fin whales could be killed if they surfaced in the midst of a large fresh oil slick and inhaled high concentrations of volatile components of crude oil. However, based on available data following both the EVOS and the *Glacier Bay* oil spill, it is unlikely that large numbers of fin whales would be adversely affected. There are no data or other information available that would suggest that there could be a population level effect on fin whales from any activity or event, such as an oil spill, that could result from the activities resulting from Sale 193.

During summer and fall, fin and humpback whales could potentially be negatively impacted by a large spill that contacted the waters adjacent to the north side of the Chukchi Peninsula, especially near Cape Dezhnev in the summer. As discussed in previous paragraphs, literature on the effects of crude oil on mammals indicates that humpback whales could be vulnerable to such a spill. There is no evidence that humpback whales were negatively impacted by the EVOS (von Zeigesar, Miller, and Dahlheim, 1994). However, this spill occurred prior to the period when most of humpbacks that summer in oiled areas of western Prince William Sound would be expected to be present.

IV.C.1.f(1)(h) Mitigation Measures. Implementing existing MMS mitigation measures (Sec. II.B.2 - Mitigation Measures), which include Standard Stipulations and Information to Lessees, as identified in Chukchi Sea Sale 126 and Beaufort Sea multiple-sale final EIS' (USDOJ, MMS, 1990a; 2003a) and stipulations associated with the seismic-survey PEA (USDOJ, MMS, 2006a), in concert with the conservation recommendations in the NMFS Arctic Region Biological Opinion (ARBO) (dated June 16,

2006), would provide the necessary protection to prevent and/or minimize adverse environmental impacts on threatened and endangered species, namely the bowhead whale.

In its ARBO issued under section 7 of the ESA, NMFS concluded that leasing and exploration are not likely to jeopardize the continued existence of the bowhead whale; however, the potential additive effects of oil and gas activities associated with exploration, production, and transportation throughout the Chukchi and Beaufort seas is of concern. In formulating their opinion, NMFS used the best information available, including information provided by MMS, recent research on the effects of oil and gas activities on the bowhead whale, and the traditional knowledge of Native hunters and the Inupiat along Alaska's North Slope. The conservation recommendations were provided to improve the understanding of the impacts of oil and gas activities on the bowhead whale, as well as to minimize or mitigate adverse effects.

Summary and Conclusions. Oil and gas exploration, development, production and abandonment could result in a considerable increase in noise and disturbance in spring, summer and autumn Arctic Ocean range of the bowhead whale from factors including, but not limited to:

- multiple 2D/3D seismic surveys in open water;
- icebreakers use;
- high-resolution seismic surveys and related main vessel noise and disturbances;
- support-vessel activities;
- open-water exploration drilling from an icebreaker-accompanied drillship;
- helicopter flights: exploration (4/day for exploration seismic); 13/day for exploration drilling; 5/day during shore-base construction; 2/day for production;
- shore-base construction at Point Belcher;
- platform construction: one bottom-founded platform-assembly noise and related disturbance;
- noise from production drilling and operations;
- pipeline construction; and
- abandonment.

Our primary concern related to these activities is that they could potentially produce sufficient noise and disturbance that bowhead whales will avoid an area of high value to them and suffer consequences of biological significance. Such areas might include: feeding or resting areas used by large numbers of individuals or by females and calves. Many of these activities are linked in space and time. For example, drilling from a drillship and icebreaker support activity are linked activities. Both have the potential to cause avoidance at considerable distance in bowhead whales.

The observed response of bowhead whales to seismic noise has varied among studies. The factors associated with variability are not entirely clear. During 3D seismic exploration conducted during fall migration in the nearshore Beaufort Sea (with 8-16 airguns totaling 560-1,500 in³), nearly all bowhead whales would avoid an area within 20 km of an active seismic source, while deflection may begin at distances up to 35 km. The area avoided by feeding whales is typically less. Avoidance may persist up to 12-24 hours after the end of seismic operations. If seismic operations are grouped, the zone of seismic exclusion could potentially be quite large. If seismic surveys were unmitigated, or are insufficiently mitigated to reduce impacts to the whales themselves, effects that are biologically significant could result if seismic surveys cause avoidance of feeding area, resting (including nursing) areas, or calving areas by large numbers of females with calves or females over a period of many weeks. Potential impacts to the population would be related to the numbers and types of individuals that were affected (e.g., juvenile males versus females with calves).

Bowheads respond to drilling noise at different distances depending on the types of platform from which the drilling is occurring. Data indicate that many whales can be expected to avoid an active drillship at 10-20 km or possibly more. The response of bowhead whales to construction in high use areas is unknown and is expected to vary with the site and the type of facility being constructed. Similarly, the long-term response of bowheads to production facilities other than gravel islands located at the southern end of the migration corridor is unknown.

An increase in exploration, development and production results in a greatly increased amount of marine vessel activity including icebreakers, barges, sealifts, seismic vessels, supply boats, crew boats, and tugs. Whales respond strongly to vessels directly approaching them. Avoidance of vessel usually begins when a rapidly approaching vessel is 1-4 km away, with a few whales possibly reacting at distances from 5-7 km. Received noise levels as low as 84 dB re 1 μ Pa) or 6 dB above ambient may elicit strong avoidance of an approaching vessel at a distance of 4 km. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period.

Icebreaker response distances vary. Predictions from models indicate that bowhead whales likely would respond to the sound of the attending icebreakers at distances of 2-25 km, with roughly half of the bowhead whales showing avoidance response to an icebreaker underway in open water at a range of 2-12 km when the sound-to-noise ratio is 30 dB and roughly half of the bowhead whales showing avoidance response to an icebreaker pushing ice at a range of 4.6-20 km when the sound-to-noise ratio is 30 dB.

Whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources.

An increase in exploration, development and production also results in greatly increased aircraft traffic. Most bowheads exhibit no obvious response to helicopter overflights at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some bowheads probably would dive quickly in response to the aircraft noise. Bowheads are not affected much by any aircraft overflights at altitudes above 300 m (984 ft). 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. Fixed-wing aircraft flying at low altitude often cause hasty dives. Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). 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. However, given the extremely high number of helicopter flights documented to support Northstar, bowheads may be repeatedly exposed to helicopter noise in areas between shore bases and/or airports and the production facilities. Depending on where shore bases, exploration activities, and production facilities are located, the effect of such interruptions could result in repeated interruption and increased stress to whales in the flight path. This could become biologically important if the whales in the area were feeding, resting, or nursing. This potential effect could be mitigated by ensuring that flight paths avoid whale aggregations or that flights are high enough to avoid disturbance.

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. There is variability in their response to certain noise sources. Some of the variability appears to be context specific (i.e., feeding versus migrating whales) and also may be related to reproductive status and/or sex or age.

Information about the current and historic distributions of fin whales and humpback whales indicate that these species are not likely to be exposed to potential noise and disturbance associated with many of the activities that could occur within the proposed Chukchi Sea Sale 193 area. Neither fin whales nor humpback whales are known to typically inhabit the proposed Chukchi Sea Sale 193 area. However, both species are known to inhabit the southwestern portions of the Chukchi Sea, in waters adjacent to the coast of Chukotka. They also inhabit the Bering Strait and northerly portions of the Bering Sea. They could be disturbed by an increase in oil and gas-related shipping through the Bering Strait that could result from increased activities in the two arctic planning areas. Such effects should be temporary and minor. Based on available information, we conclude it is unlikely that there will be adverse effects on either fin whales or humpback whales from noise causing activities in the proposed Chukchi Sea Sale 193 area.

The effects of a large oil spill and subsequent exposure of the bowhead whale population to fresh crude oil would depend on how many whales contacted oil; the ages and reproductive condition of the whales contacted; the duration of contact; the amount of oil spilled; and the age/degree of weathering of the spilled oil at the time of contact. Ingestion, surface contact with, and especially inhalation of fresh crude oil has been shown to cause serious damage and even death in many species of mammals. 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 spilled into leads or ice-free areas frequented by migrating bowheads, a large portion of the population could be exposed. If a large slick of fresh oil contacted a large aggregation or aggregations of feeding bowheads, especially with a high percent of calves, the effect might be expected to be greater than under more typical circumstances. There is great uncertainty about the effects of fresh crude oil on cetacean calves. Prolonged exposure to freshly spilled oil could cause adult whale mortalities, but based on available information, the number likely would be small if the spill contacted bowheads in open water. Bowhead whales would be particularly vulnerable to effects from oil spills during their spring migration because of their use of ice edges and leads, where spilled oil would tend to accumulate. Bowheads may also have heightened vulnerability to spilled oil because of the functional morphology of their baleen. If baleen is fouled, and if crude oil is ingested, there could be adverse effects on the feeding efficiency and food assimilation of bowhead whales. Such effects are expected to be of most importance to calves, pregnant females, and lactating females. However, loss of feeding efficiency could potentially reduce the chance of survival of any whale and could affect the amount of energy female whales have to invest in reproduction.

It is likely that some whales would experience temporary or perhaps permanent nonlethal effects, including one or more of the following symptoms:

- inhaling hydrocarbon vapors;
- ingesting oil and oil-contaminated prey;
- fouling of their baleen and reduced foraging efficiency;
- oiling their skin, causing irritation;
- losing some proportion of their food source; and,
- temporary displacement from some feeding areas.

In conclusion, there is uncertainty about effects on bowheads (or any large cetacean) in the event of a large spill. There are, in some years and in some locations, relatively large aggregations of feeding bowhead whales within the proposed lease-sale area. If a large amount of fresh oil contacted a significant portion of such an aggregation, effects potentially could be greater than typically would be assumed and we cannot rule out population-level effects if a large number of females and newborn or very young calves were contacted by a large amount of fresh crude oil. Oil spill response activities (including active attempts to move whales away from oiled areas) could cause short-term changes in local distribution and abundance.

IV.C.1.f(2) Threatened and Endangered Species – Marine and Coastal Birds. Section 7 of the ESA requires consultation with the FWS for any Federal action that could adversely affect listed species and their critical habitats within the Proposed Action area. The spectacled eider and the Steller's eider are listed as Threatened under the ESA. The Kittlitz's murrelet is designated a candidate species under the ESA. Critical habitat for the spectacled eider has been designated in Ledyard Bay, part of the Proposed Action area. The MMS Biological Evaluation and FWS Biological Opinion are large documents. The MMS Biological Evaluation is available at the MMS website (http://www.mms.gov/alaska/ref/Biological_opinionsevaluations.htm) or from MMS. The FWS Biological Opinion is available at the same MMS website or from the FWS Field Office in Fairbanks, Alaska.

The FWS BO concluded that 3 adult spectacled eiders and 1 adult Steller's eider may be incidentally taken through collisions with structures during activities authorized during leasing and exploration activities resulting from Lease Sale 193. If spectacled and Steller's eider populations continue to decline, any such losses would not be recovered within a generation and the MMS would consider this take to be a significant impact.

There is no authorized take associated with oil spills as they are considered an unlawful activity. If spectacled and Steller's eider populations continue to decline, any spectacled or Steller's eider mortality associated with an oil spill would be a significant impact.

IV.C.1.g. Marine and Coastal Birds.

IV.C.1.g(1) Summary. Marine and coastal birds could be exposed to a variety of impacts during seismic surveys, exploration drilling, and production, including disturbances, collisions, habitat loss, petroleum

exposure, and exposure to toxic contamination. Spilled oil has the greatest potential for affecting large numbers of birds in part due to its toxicity to individuals and their prey, loss of feather insulation causing hypothermia/drowning, and the difficulties involved in cleaning up spills in remote areas, given the wide variety of possible ice conditions. For example, a large spill could impact common and thick-billed murre in late summer and early fall, when juveniles and attendant males are floating throughout the Chukchi Sea. During this period, juveniles have not yet developed the ability to fly and attendant males are flightless for several weeks while molting. This inability to move quickly out of the area coupled with the potential for affecting large numbers of birds could sharply decrease murre abundance at the Cape Thompson and Cape Lisburne colonies.

There are several areas historically documented to be important to marine and coastal birds in the proposed lease sale area. These areas, as well as the entire proposed lease sale area, lack site-specific data on habitat use patterns, routes and timing to assess impacts. For many species, the most recent data is between 15 and 30 years old, making accurate analysis difficult. For example, Kasegaluk Lagoon and Peard Bay provide important habitat to a variety of waterfowl and shorebirds and a large spill during a period of peak use could affect large numbers of birds. Up to 45% of the estimated Pacific Flyway population of Pacific brant could be affected if a large oil spill reaches Kasegaluk Lagoon. The effects of a large spill could range from direct mortality of approximately 60,000 brant to sublethal effects on an equal or smaller number of brant.

The Ledyard Bay area is part of the spring lead system that appears to be a stopover point for a substantial proportion of all seaducks moving to breeding areas on the Arctic Coastal Plain or western Canada. Similarly, this same area appears important to many of these same birds once they leave breeding grounds and molt or stage prior to migrating to wintering areas.

Overall, several species or species-groups have a high probability of experiencing substantial negative impacts in the event of an oil spill. The risk that several regional bird populations could experience significant adverse impacts from a large oil spill is high.

IV.C.1.g(2) Potential Effects of Seismic Surveys on Marine and Coastal Birds. Seismic surveys could have a variety of potential impacts to marine birds. These include the physical presence and noise produced by vessels, sound produced by the seismic airguns, and the physical presence and noise produced by support aircraft. Marine birds could be exposed to petroleum products in the event of an accidental spill.

IV.C.1.g(2)(a) Disturbances from Vessels, Seismic Airguns, and Support Aircraft.

IV.C.1.g(2)(a)1 Vessel Presence and Noise. The response of marine and coastal birds to disturbances can vary depending on the species, time of year, disturbance source, habituation, and other factors (Fox and Madsen, 1997). For some species of waterfowl, the distance at which disturbances will be tolerated varies depending on flock size, because larger flocks react at greater distances than smaller flocks (Madsen, 1985). There is an energetic cost to moving away from a disturbance as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability. Birds undergoing a flightless molt are even more vulnerable to disturbance impacts as they are already physiologically stressed.

Seismic survey activities are not anticipated to occur in near-shore waters where many marine birds are found. Seismic survey vessels would remain at least 17 km (10 mi) offshore, so they would not come close to bird nesting areas. It is more likely that vessels might disturb marine and coastal birds that are foraging, resting or molting at sea.

Implementation of mitigation measures (see Sec. IV.C.1.g(5)) would reduce the potential for seismic vessel and aircraft disturbance to marine birds.

IV.C.1.g(2)(a)2 Seismic Airgun Noise. Seismic airgun noise is propagated underwater both vertically and horizontally. It is considered unlikely (but remains unproven) that birds would ever be under the seismic array, but birds could be affected by sounds propagating horizontally away from the array. Although there is variation in attenuation rates depending on bottom slope and composition, sound from

airgun arrays can be detected using hydrophones at ranges of 50-75 km (30-45 mi) in water 25-50 m (75-150 ft) deep (Richardson et al., 1995a).

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

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

Seismic airgun noise has the potential to affect fish and invertebrates (see discussion in Sec. IV.C.1.d Fish Resources). However, the effects of seismic surveys on marine fish that might change their availability to marine birds have not been documented under field operating conditions (CDFO, 2004d). If forage fishes are displaced by airgun noise, birds feeding on those resources might be temporarily displaced and stop feeding within about 30 km of survey activities (see Sec. IV.C.1.d(2)(b)2 Impacts to Behavior).

Seismic airgun noise also has the potential to alter the availability of other marine bird prey. Research indicates that there are few effects on invertebrates from noise produced by airguns unless the invertebrate is within a few feet of the source (Brand and Wilson, 1996; McCauly, 1994). Consequently, noises from seismic airguns are not likely to decrease the availability invertebrate crustaceans, bivalves, or mollusks.

Seismic airgun pulses have the potential to physically harm or kill diving birds. The threshold for physiological damage, namely to the auditory system, for marine birds is unknown. Although MMS has no information about the circumstances where this might occur, the reactions of birds to airgun noise suggest that a bird would have to be very close to the airgun to receive a pulse strong enough to cause injury, if that were possible at all.

During on-going surveys, diving birds are likely to hear the advance of the slow-moving survey vessel and associated airgun noise and move away. We assume that birds would choose to avoid noises that bother them. The mitigation measure to ramp up (the gradual increase in decibel level as the seismic activities begin (see Sec. IV.C.1.g(5))) would allow diving birds to hear the start-up of the seismic survey and help disperse them before harm occurs. Furthermore, documenting bird reactions to seismic survey vessel activities may help further evaluate the potential for marine birds to be harmed by airgun noises (see Sec. IV.C.1.g(5)).

IV.C.1.g(2)(a)3 Support Aircraft Noise. The noise and presence of aircraft operating at low altitudes have the potential to disturb birds. Birds would flush or move away from the noise and approaching

aircraft. There is an energetic cost to repeatedly moving away from aircraft disturbances as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability. Support aircraft flying over nesting areas could flush adults from nests with could lead to abandonment or egg/chick death from exposure to the elements or predators. Low-level flights over rearing broods could also result in the separation of adults and young, with similar consequences.

Implementation of certain mitigation measures would reduce the magnitude and frequency of aircraft-related noise disturbances to coastal and marine birds (see Sec. IV.C.1.g(5)).

IV.C.1.g(2)(b) Collisions with Vessels and Aircraft. Migrating birds colliding with manmade structures has been well documented in the literature. Weather conditions such as storms associated with rain, snow, icing, and fog or low clouds at the time of the occurrences often are attributed as causal factors (Weir, 1976; Brown, 1993). Lighting of structures, which can be intensified by fog or rain, also has been identified as a factor (Avery, Springer, and Dailey, 1980; Brown, 1993; Jehl, 1993). Birds are attracted to the lights, become disoriented, and may collide with the light support structure (e.g., pole, tower, or vessel).

Vessel Strikes. Lights on fishing vessels at sea have been known to attract large numbers of seabirds during storms (Dick and Donaldson, 1978). Black (2005) reported a collision of about 900 birds, mostly a variety of petrel species and Antarctic prion (*Pachyptila desolata*), with a 75-m (225 ft) fishing trawler near South Georgia. The collisions took place over a 6-hour period at night, when visibility was less than 1 nm due to fog and rain. Of the 900 birds on deck, 215 were dead. Most of the remaining birds were released alive after being allowed to dry off in boxes stored in a protected area on deck. Waterfowl and shorebirds also have been documented as colliding with lighted structures and boats at sea (Schorger, 1952; Day et al., 2003).

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

Marine birds are at risk of collisions with seismic-survey vessels at night or during periods of rain/fog due to their attraction and subsequent disorientation from high-intensity lights on ships. A mitigation measure to turn off high-intensity lights when not needed would reduce the potential that marine and coastal birds would be attracted to and strike seismic survey vessels (see Sec. IV.C.1.g(5)).

Aircraft Strikes. Seismic-survey-support aircraft operating at low altitudes have the potential to flush birds into the path of the aircraft where a collision could occur. While such strikes are relatively rare, implementation of mitigation measures could reduce the frequency of strike risk to marine and coastal birds (see Sec. IV.C.1.g(5)).

IV.C.1.g(2)(c) Petroleum Exposure. Marine and coastal birds could be affected by a survey-vessel accident resulting in a petroleum spill. Direct oiling of marine and coastal birds likely would result in loss of feather insulation and acute and chronic toxicity from ingestion and absorption (see Sec. IV.C.1.g(3)(g) Effects of Large and Small Oil Spills). Oiled birds could also carry oil to nests where eggs and young could be oiled.

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

Each streamer cable in the airgun array may contain 100-200 liters of a kerosene-like fluid to provide buoyancy. Breaks in these cables are rare and typically only occur when currents whip cables around a structure such as an oil platform. Surveys need to be conducted in a relatively ice-free environment, so there is only a small chance of damage to survey vessels from ice. Seismic surveys in the Chukchi Sea would be done in open water, far away from structures that would present a risk of entanglement and a

spill. Newer generation streamer cables are filled with foam and, if used, they would eliminate any risk of a spill presented by fluid-filled cables.

According to oil-spill records, most accidental spills in Alaska happen in harbors or during groundings; consequently, spills from vessels on the high seas where pelagic birds are mostly found in the Chukchi Sea would be an uncommon occurrence. The MMS believes that the risk of incidents involving the release of oil and fuel from vessels during seismic survey activities will likely be small. This conclusion is based on the assumption that there would be no unauthorized discharges from the seismic vessel, such as the discharge of engine oil, etc. Therefore, any effects would be due to accidental discharges, such as a spill of fuel oil during a fuel transfer from a support vessel to a seismic vessel. The MMS assumes further that the operators would be cautious and vigilant during fuel transfers; for example, if a fuel hose broke, the fuel valves would be shut off quickly. Given that the risk of incidents is likely small and that the seismic surveys will typically be working more than 17 km (10 mi) from shore, petroleum exposure from seismic-survey activities is not addressed as a specific category during the exploration and development phases.

IV.C.1.g(3) Potential Effects of Exploration and Production on Marine and Coastal Birds. Following seismic surveys to locate potential oil-bearing geologic formations, exploration and delineation of the geologic formation occurs. Exploration typically involves the use of drill ships or moveable platforms during the open water period. If a marketable quantity of oil is found, production may occur. As described in the development scenario, a large bottom-founded platform would be constructed to accommodate pipelines from surrounding wells and redirect the oil to shore via a subsea pipeline.

Exploration and production could have a variety of potential impacts to marine and coastal bird species from the physical presence and noise produced by vessels and the physical presence and noise produced by support aircraft. Marine and coastal birds are at risk of collisions with aircraft, vessels, and structures. Additionally, marine and coastal birds may be affected by habitat loss, oil spills from platforms or pipelines, and toxics contamination.

Development and production could have a variety of potential impacts to marine and coastal birds from the disturbance associated with heavy equipment, vessels, and support aircraft during construction and operation of production platforms, undersea and overland pipelines, as well as shore based infrastructure and roads. Marine and coastal birds could be exposed to chronic or acute petroleum products in the event of an accidental spill as well as to habitat loss and toxics contamination.

IV.C.1.g(3)(a) Important Factors in Assessing Potential Effects. Several factors are important in determining the magnitude of effects from oil exploration and production. Based on these factors and their relation to habitat utilization by birds, it is often possible to make realistic predictions of ecological effects.

IV.C.1.g(3)(a)1) Timing. The window of time for exploration typically includes the open-water period. Accordingly, this largely eliminates potential effects during spring migration for marine and coastal birds, unless exploration vessels traverse the spring lead system. Effects still are possible during open-water periods where activities could affect birds that are molting, foraging, and migrating after the breeding season. For production, operations would take place year round and effects would be possible from a variety of sources throughout the year.

IV.C.1.g(3)(a)2) Residence Time and Periodicity. Effects vary based on whether activity in the area is short- or long-term and whether it involves passage through an area on a frequent or intermittent basis. During exploration, drill ships could be at a particular location for about 90 days, depending on the site characteristics. Support vessels and aircraft would likely need to make trips between the drill ship and shore to deliver personnel and equipment. Residence time and periodicity of drill ships and support vessels during exploration could affect molting, foraging, and postbreeding migrant marine and coastal birds. For production, permanent structures would be placed at sea, under the ocean floor and on **land. The operational life of a production project would span a minimum of several decades.**

IV.C.1.g(3)(a)3) Spatial Extent. The lease sale area is large and the area explored in any given season is small by comparison. Beyond the footprint of the drill ship, consideration must be given to the area affected by noise, support vessel traffic, and the area that might be impacted in the event of an oil spill.

Effects of oil spills are not confined to the proposed lease sale area and can affect marine and coastal birds outside the area boundaries.

IV.C.1.g(3)(a)4 Environmental Factors. Weather, currents, wind and other environmental variables all influence the intensity or magnitude of potential effects. Limited visibility due to fog, rain, and snow can affect the ability of birds to detect structures and avoid them. Limited visibility coupled with bright lights may also attract birds and increase the risk of collisions. Wind and currents can also affect the speed and direction of oil spills. Spills in calm conditions with minimal current could result in a small impacted area while a similar spill in an area with strong currents during a period of high wind and rough seas could increase the size of the impacted area.

IV.C.1.g(3)(b) Disturbances from Vessels, Support Aircraft, and Production Infrastructure. General effects of disturbance from vessels and support aircraft are presented above in the seismic exploration (Sec. IV.C.1.g(2)). Only additional issues pertinent to exploration and production are presented in this section.

During exploration, disturbance could come from the physical presence of drill ships or platforms, support vessels, and aircraft as well as from noise generated during operations. Seismic exploration and drill-ship exploration likely would occur in separate years, but both would occur at similar times of the year and during similar environmental conditions. Disturbance from drill ships would likely be less than seismic-survey vessels, because drill ships remain in one location for about 90 days and, therefore, may only drill at two sites during an open-water season. Support vessels and aircraft activity likely would be less than during seismic surveys, because they would only need to support two drill ships compared to three or four seismic-survey vessels. Importantly, the duration of vessel and aircraft traffic would be longer in the vicinity of the drill ships than the mobile seismic vessel, but there would be a smaller area disturbed because the drill ship or platform is stationary.

Drill ships radiate the most underwater noise when compared to semisubmersible vessels or any other structure such as natural, manmade, or caisson-retained islands or from other platforms (Greene and Moore, 1995). The noise, however, is localized, because a drill ship typically remains in one location for about 90 days. When transiting between drill locations, noise from the drill ship likely would be similar to other ships already passing through the region. Data regarding bird behavior around drill ships has not been published, but reactions may be similar to seismic surveys where birds likely would avoid diving within a certain distance of the drill ship because of underwater noise and other rig activity. This temporary disturbance from drilling is considered an indirect habitat loss. This habitat loss would affect a zone of influence around the drilling structures. It is not possible to determine the size of this zone at this point, because the attenuation rates of underwater noise depend on the water depth, bathymetric profile, and bottom composition. There also would be noise audible on the surface from generators and compressors on the drill ship. The size of the zone of influence also may vary based on the tolerance level of different bird species.

The lease sale boundary includes a portion of the spring lead system, where large numbers of pre-breeding eiders and other waterfowl concentrate before moving to their breeding grounds. Chronic disturbances to these birds from vessels or low-flying aircraft, or a small accidental spill, could result in adverse impacts to a large number of birds. Given the substantial risk that vessels would incur in entering this narrow ice-free area, the anticipated amount of disturbance is low. Monitoring of vessel/aircraft traffic would allow validation of this assumption (see Sec. IV.C.1.g(5)).

Due to the presence of drill ships and support vessels operating in a small area, the risk of disturbance from vessel presence and activity could be considered low from drill ship operations, but disturbance from support vessels and aircraft traveling to shore could be extensive due to the number of trips and the distances traveled. By operating support vessels along predesignated routes and aircraft along predesignated routes and altitudes, risk of disturbance from vessels and aircraft could be minimized (see Sec. IV.C.1.g(5)).

Potential avenues of disturbance associated with the Proposed Action during development include construction of a production platform, an onshore base, pipelines, and roads; gravel mining/transport; pipeline maintenance; and oil-spill-response training. The location of these facilities is unknown.

Infrastructure associated with development and production would be present year-round and would remain in the area for at least several decades.

The proposed sale area includes the foraging range of murre from the Cape Lisburne and Cape Thompson colonies. The construction of a production platform within or in close proximity to these areas could result in disturbance impacts to murre from various sources of noise and human activity associated with support vessels and aircraft. Long-term disturbances that result in displacement of murre or other marine or coastal birds can technically be considered a loss of habitat. For example, regular vehicle traffic or pipeline maintenance roads could result in the permanent displacement of birds from a zone of influence around this development. The size of this zone would likely vary between species based on species-specific tolerance levels.

The construction of a pipeline between a production platform and an onshore base could cross many important bird habitats, including Ledyard Bay and Kasegaluk Lagoon. Depending on the construction season, the construction of a pipeline could displace and/or disturb marine and coastal birds in a variety of pelagic, nearshore, estuarine, and terrestrial habitats. Many of these disturbing activities could have fewer impacts to many birds if they were to occur during the winter, when most birds are not present. Due to the uncertainty of routes, specific conservation measures to avoid or minimize disturbance from activities associated with onshore bases and pipelines are not included in the Proposed Action. Disturbances associated with potential development projects would be evaluated in future NEPA documents.

IV.C.1.g(3)(c) Collisions. General effects of collisions with vessels and aircraft are presented above in Sec. IV.C.1.g(2). Only effects specific to exploration and production are presented in this section.

Exploration and Production Infrastructure Strikes. Marine and coastal birds can be killed by collisions with onshore and offshore structures (i.e., drilling structures, communication towers with support cables, overhead power lines, etc.). As described previously, effects from collisions with vessels and aircraft also would be likely during development and production, because both are needed to construct the undersea pipeline and drilling platforms and provide continual support.

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

The greatest potential for collision impacts would be if structures were within the areas where the majority of marine and coastal birds are known to migrate. Similar to previous lease sales and resultant terms and conditions from FWS Biological Opinions, stipulations for the proposed lease sale could specify a requirement that structures must be lighted in such a manner to minimize collisions from spectacled and Steller's eiders. These stipulations also could benefit other coastal and marine birds. There appear to be two important aspects of collision avoidance to consider in implementing this stipulation. Light radiated upward and outward from the structure could disorient flocks of sea ducks and other birds during periods of darkness or inclement weather when the moon is obscured. If migrating birds were not disoriented by radiated light, they could still encounter structures in their flight paths. Making surfaces visible to approaching birds may slow flight speed, allowing them to maneuver past collision hazards. Inward-directed lighting would illuminate these surfaces, but surface textures that absorb, rather than reflect, light could maximize visibility to closely approaching birds and minimize disorientation of distant birds during periods of darkness or inclement weather. Implementation of conservation measures could reduce the potential for collision impacts at exploration or production platforms (see Sec. IV.C.1.g(5)).

IV.C.1.g(3)(d) Habitat Losses. In the exploratory and delineation phase, direct habitat loss could occur if wells were drilled in offshore bird habitats. The physical footprint of the drill ship and support vessels amounts to temporary direct habitat loss, while the area surrounding the drill ship and support vessels might be avoided by birds due to disturbance would be considered indirect habitat loss. While a similar area of habitat loss could be expected from drilling anywhere in the lease-sale area, drilling within known foraging ranges of murre colonies, for example, could result in a greater impact than lesser used pelagic locations.

The size and location of permanent developments associated with a future phase of oil production are unknown but are speculated to occur offshore and then be connected via pipeline to an onshore base close to the existing airport at Barrow or Wainwright. It would then be the shortest, practicable route east to connect with pre-existing support infrastructure. The routing of pipelines and associated service roads or gravel-extraction sites cannot be evaluated at this time but could result in direct impacts to marine and coastal bird nesting habitats. Similarly, many long-term disturbing activities could have fewer impacts to marine and coastal birds if they were to occur during the winter, when these birds are not present. Specific conservation measures to identify and subsequently minimize impacts to high-value nesting, broodrearing, or molting habitats when constructing and maintaining these facilities during the production phase are not included in the Proposed Action, but are anticipated to be evaluated in future NEPA documents.

IV.C.1.g(3)(e) Increased Subsistence Activity. Alaskan Natives have traditionally harvested marine and coastal birds and their eggs in coastal villages during spring and fall. The Proposed Action assumes that if recoverable amounts of oil are discovered and produced, that delivery systems (pipelines) would carry products eastward to pre-existing infrastructure for transport to processing facilities. The pipelines would need associated roads for periodic maintenance and these roads could increase access of local hunters to previously inaccessible areas. Waterfowl hunters could access pipeline roads during the period immediately following spring breakup to hunt geese and other waterfowl. It is unknown what that level of harvest is, or whether the increased access scenario depicted here would result in an increased harvest following the creation of roads along a pipeline constructed from an onshore base to other anticipated pipelines in the National Petroleum Reserve-Alaska (NPR-A). These roads could essentially allow for travel between Wainwright to the Prudhoe Bay area and beyond, and vice versa. The long-term consequences of these developments would be evaluated in future NEPA documents and access controls could be implemented if warranted.

IV.C.1.g(3)(f) Increased Predator Populations. Predation is believed to be a principal cause for nesting failure in many marine and coastal bird species. Predators of marine and coastal birds along the Chukchi Sea are likely similar to those identified for the Beaufort Sea for the most recent proposed lease sales. Those predators included snowy owls, peregrine falcons, gyrfalcon, pomarine and long-tailed jaegers, rough-legged hawks, common ravens, glaucous gulls, and Arctic and red foxes. The current distribution and abundance of these predators along the Chukchi Sea coast are unknown. The distribution and abundance of these predators along the Chukchi Sea coast, however, are believed to be limited due to a lack of suitable nesting or denning habitat and prey base.

Substantive depredations of waterfowl eggs and young in the Arctic region can occur, especially where predator populations have increased because of access to human developments and increased access to food/garbage and nesting (poles, towers, etc.) or denning (fill pads, roads, etc.) sites. Increases in predator abundance and distribution could occur along the Chukchi Sea coast as development infrastructure spreads eastward towards production sites resulting from the proposed lease sale.

The greatest direct impact on marine and coastal bird populations would occur when predator densities are high and densities of nesting birds are low. Excessive predation on nesting females can also result in imbalanced sex ratios within populations.

IV.C.1.g(3)(g) Effects of Large and Small Oil Spills. Marine and coastal birds could be exposed to petroleum during development and production. Potential sources of crude oil include spills from platforms and pipelines. These spills could occur on or near the platform as well as the undersea pipelines. Potential spills of refined petroleum such as diesel fuel or hydraulic oil include sources such as machinery found on production platforms as well as support vessels. Oil in the Chukchi Sea would be a serious threat to seabirds because of its properties of forming a thin, liquid layer on the water surface. Seabird deaths due to oil spills arise from exposure from wetting and loss of thermoregulatory ability, loss of buoyancy, or from matted plumage, inability to fly or forage, and inhalation of vapors (Fry and Lowenstine, 1985). Alcids and sea ducks are highly vulnerable to oil spills because they spend most of their time on the sea surface and aggregate in dense flocks.

Potential effects from oil spills range from acute exposure where a bird may be completely covered by a lethal amount of oil to chronic exposure where a bird may be exposed to smaller amounts of oil over a longer period of time. The residence time of a bird in a particular area as well as habitat use patterns and

the spatial extent of a spill are important factors in determining the level of chronic exposure. The effects of exposure can range from lethal to sublethal, although acute exposure can often lead to lethal effects. The true numbers of birds killed by acute toxicity often are difficult to document, because many birds do not wash up on shore or are difficult to detect by aerial surveys. Sublethal effects are especially difficult to assess in wild birds due to the wide variety of factors that could lead to such things as reproductive impairment or susceptibility to disease. For example, sublethal effects from oil could lead to immunosuppression and, therefore, increase susceptibility to disease. However, birds often die from disease without any known prior exposure to petroleum. Accordingly, it is often difficult to determine whether a bird died to sublethal effects of oil or simply from a disease.

Common routes of exposure to oil include covering skin or feathers, inhalation of vapors, and ingesting oil or contaminated prey. These routes of exposure can lead to reproductive effects, reduced food sources, and displacement from feeding or molting areas. In the event of an oil spill in marine and coastal bird habitats in the Chukchi Sea, some birds could be affected by the following routes of exposure.

IV.C.1.g(3)(g)1) Covering of Skin or Feathers. Fouled plumage is the primary cause of mortality and stress in oiled birds (Burger and Fry, 1993). The hydrophobic nature of petroleum hydrocarbons makes them interactive with the hydrophobic properties of bird feathers. Oil causes marked loss of insulation, waterproofing, and buoyancy in the plumage. Oiled feathers lose their ability to keep body heat in and cold water out, and resultant hypothermia can kill birds. Waterlogging and loss of buoyancy can rapidly lead to drowning.

IV.C.1.g(3)(g)2) Inhaling Hydrocarbon Vapors. Birds have the most efficient respiratory system of all vertebrates (Welty, 1975) and could be more susceptible to harm from inhaling hydrocarbon vapors than mammals. The following conclusions are based on Geraci and St. Aubin (1982) as applied to birds. Inhaled petroleum vapors are absorbed into the bloodstream and carried throughout the body. Inhalation of highly concentrated petroleum vapors can lead to inflammation and damage of the mucous membranes of the airways, lung congestion, emphysema, pneumonia, hemorrhage, and death. It is unlikely that vapor concentrations can reach critical levels for more than a few hours. If a bird were unable to leave the immediate area of the source of the spill or were confined to a contaminated lead or bay, it could inhale enough vapors to cause some damage. Birds away from the immediate spill area or exposed to weathered or residual oils would not be expected to suffer any adverse effects from vapor inhalation.

IV.C.1.g(3)(g)3) Ingesting Oil or Contaminated Prey. The most likely way birds would ingest oils is by preening it off their feathers after exposure. Petroleum oils contain many toxic compounds that can have fatal or debilitating effects on seabirds. Most petroleum oils contain compounds that are highly toxic to birds and cause damage and sometimes death to birds when ingested (Burger and Fry, 1993). Some of these toxic compounds could be absorbed through the skin. Both crude and bunker oils produced intestinal irritation in birds. Oils with high polyaromatic hydrocarbon contents are known to cause precipitation of hemoglobin leading to anemia. In experiments with two species of marine birds, Leighton, Peakall, and Butler (1983) found that severe hemolytic anemias occurred from ingestion of large amounts of crude oil.

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

IV.C.1.g(3)(g)4) Reproductive Effects. Ingested oil causes short- and long-term reproductive failure in birds, indicative of severe physiological problems. These include delayed maturation of ovaries, altered hormone levels, thinning of eggshells, reduced egg productivity, reduced survival of embryos and chicks, reduced chick growth, and abandonment of nests by adults (Burger and Fry, 1993). For example, Cassin's auklets experienced reduced reproduction after exposure to Prudhoe Bay crude oil (Ainley et al., 1981). It is unknown if exposed adults could become permanently sterilized.

If adults engaged in a futile attempt to hatch a dead embryo, their reproductive effort for that year would be lost. Even if they were to attempt to renest later in the season, it is doubtful that their late-hatching young would survive. Due to a short summer period at northern latitudes and the high energetic investment in egg laying, many seabirds are capable of raising only one chick or clutch per year.

In some species of marine birds, both parents incubate eggs and bring fish for their young. Lightly oiled birds could bring oil contamination back to their nest where eggs and young could be contaminated. Couillard and Leighton (1989) documented that chicken embryos treated with 10-20 microliters of Prudhoe Bay Crude Oil on the eggshell developed marked ascites or subcutaneous edema, extensive liver necrosis, dilation of the heart, and cellular casts and mineralization in renal tubes. Lightly oiled birds also could bring contaminated food to the nest. Heavily oiled birds would be prevented from returning to the nest, resulting in the young dying of starvation.

IV.C.1.g(3)(g)5 Reduced Food Sources. Food resources used by marine and coastal birds could be displaced from typical foraging habitats or reduced following an oil spill. Benthic habitats that support marine invertebrates, however, would not be expected to experience substantial adverse effects following an oil spill. Vegetated habitats within coastal lagoons, however, could experience immediate and prolonged impacts from a spill.

IV.C.1.g(3)(g)6 Displacement from Feeding or Molting Areas. The presence of substantial numbers of workers, boats, and aircraft activity between the spill site and support facilities is likely to displace marine and coastal birds foraging in affected offshore or nearshore habitats during open-water periods for one to several seasons. Disturbance during the initial response season, possibly lasting as long as 6 months, is likely to be frequent. Cleanup in coastal areas late in the breeding season may disturb broodrearing, juvenile, or staging birds.

Summary of Oil-Spill Effects: The synergetic effects of oiled plumage, osmotic and thermal stress, and anemia could increase greatly the mortality of marine and coastal birds under adverse environmental conditions.

IV.C.1.g(4) Probabilities of Contacting Spilled Oil. Whether marine and coastal birds would come into contact with oil would depend on the location, timing, and magnitude of the spill; the presence and extent of landfast ice and broken ice; and the effectiveness of cleanup activities.

In the following sections, an Environmental Resource Area (ERA) is a polygon that represents a geographic area that exists seasonally. An ERA can represent an area important to one or several species or species groups during a discrete amount of time. The ERA locations are found in Appendix A, Maps A.1-2a-2d and the launch areas (LA) and pipeline segments (P) are found in Appendix A, Map A.1-4a. Spills may contact a land segment (LS).

IV.C.1.g(4)(a) Sale-Specific Probabilities of Contacting Oil Spills. This section describes the conditional probabilities estimated by the OSRA model of a large oil spill in the Chukchi Sea contacting specific ERAs that are important to marine and coastal birds. No large oil spills are assumed to occur during exploration activities. Using the 95% CI spill rate the total number of large platform and pipeline spills range from 0.32 to 0.77, with a 27-54% chance of one or more large spills occurring over the life of the project (Appendix A, Table A.1-27). For the development and production phases, the fate and behavior of a 1,500-bbl spill from a platform or a 4,600-bbl spill from a pipeline were evaluated using SINTEF Oil Weathering Model (Appendix A). The 1,500-bbl spill would cover a smaller discontinuous area (577 km²) (Appendix A, Table A.1-9) than a 4,600-bbl spill (1,008 km²) (Appendix A, Table A.1-10) after 30 days. The OSRA uses the center of the mass as the contact point, so the probabilities of either spill contacting specific ERAs would be the same. Because of this similarity, only the 4,600-bbl spill is analyzed in this section.

A 4,600-bbl spill could contact ERA's where marine and coastal birds may be present. Approximately 44% of a 4,600-bbl spill during the open-water period would remain after 30 days, covering a discontinuous area of 1,008 km². A spill during broken ice in fall or under ice in winter would melt out in the following summer. Approximately 55% of a 4,600-bbl spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 332 km².

The following paragraphs present conditional and combined probabilities (expressed as a percent chance) estimated by the OSRA model of a spill contacting or occurring and contacting many of the best known habitats that are important to marine and coastal birds. Given the wide variety of bird species that use the proposed lease-sale area and factoring in continuous changes in prey abundance and other biotic and abiotic factors that affect bird distribution, it is possible that large aggregations of birds could be at risk from a large spill anywhere in the lease-sale area. For instance, short-tailed shearwaters and some auklet species occur during the summer throughout the lease sale area, but a large spill could contact large numbers of them or none at all, depending on the location of the spill and location of the birds at the time of the spill. Better data exist for other marine and coastal bird species, which facilitates risk assessments with greater certainty. For many marine species, it is not possible to assess the chance of contact with oil with a high degree of confidence. Conditional probabilities are based on the assumption that a large spill has occurred (see Appendix A). Combined probabilities, on the other hand, factor in the chance of one or more large spills occurring.

Conditional probabilities in the following discussions, unless otherwise noted, are conditional probabilities estimated by the OSRA model of a large spill contacting the ERA's being discussed within 180 days during summer or winter (Appendix A, Tables A.2-29 or A.2-53).

IV.C.1.g(4)(a)1 Summer Spill. For conditional probabilities, the OSRA model estimates that a <0.5-71% chance that a large oil spill starting at LA's 1-13 will contact ERA's 1-98 and a <0.5-67%, assuming a large spill starts at P1-P11. The highest percent chance of contact from a launch area occurs at ERA 56, which has a 57% chance of contact from a large spill occurring at LA 12. The chance of contact to this ERA is highest, because the OSRA model's launch area and the ERA are in close proximity to or overlap each other. The highest percent chance of contact from a pipeline segment occurs at ERA's 56 and 6, which have a 67% chance of contact from a large spill occurring from P8 and P11, respectively. As with the launch areas, the chance of contact in these ERAs is highest, because the OSRA model's pipeline segment and the ERA are in close proximity to or overlap each other.

Many pre- and postbreeding shorebirds and waterfowl stage at Kasegaluk Lagoon, while other bird species breed or molt in or near the lagoon. Large spills originating from P6 have a 34% chance of contacting ERA 1 (Kasegaluk Lagoon) during the May-October open-water period.

Waterfowl and shorebirds use Peard Bay, especially in the summer and fall after the ice is out to breed, molt, and forage during migration. Large spills originating from P11 have a 56% chance of contacting ERA 64 (Peard Bay) during the May-October open-water period.

Murres forage over a wide area of the Chukchi Sea during the breeding season and cover a much larger area later in the summer and fall when juveniles are floating flightless at sea during their at-sea rearing period. Attendant male murres also are flightless while molting during this period. The core of this area is represented as polygon ERA 18. The OSRA model estimates a 42% and 37% chance of a large spill contacting ERA 18 during the May-October open-water period from LA 9 and P1, respectively. Spilled oil contacting this ERA polygon is assumed to contact all birds using this area.

The OSRA model estimates a 58% chance of a large spill contacting ERA 15, directly adjacent to the murre breeding colonies near Cape Lisburne, during the May-October open water period. Spilled oil contacting this ERA polygon is assumed to contact any birds using this area. This risk also applies to other seabirds breeding at Cape Lisburne including black-legged kittiwakes, puffins, and smaller numbers of glaucous gulls and pelagic cormorants. Similar species are located at colonies near Cape Thompson. The OSRA model estimates a 51% chance of a large oil spill contacting ERA 14 (Cape Thompson) during the May-October open-water period. Spilled oil contacting this ERA polygon is assumed to contact all birds using this area.

The OSRA model estimates up to a 34% chance that a large oil spill would make contact with the spring lead system (ERA's 19-28) used by marine and coastal birds as they move east to breeding areas or stage offshore if breeding habitats were unavailable. The percent chance of contact increases later in the season, as postbreeding birds leave their nesting grounds and stage offshore and begin migration to the west.

A potential mitigation measure that could help reduce the extent and impact of large spills involves staging spill-response equipment and bird-rescue/at-sea hazing gear near a production platform or onshore to avoid delays in transporting this equipment from other oil-production sites on the North Slope (see Sec. IV.C.1.g(5)).

IV.C.1.g(4)(a)2) Winter Spill. For conditional probabilities, the OSRA model estimates a <0.5-54% chance of a large oil spill starting at LA 1-13 contacting ERA's 1-98, assuming a large spill occurs, and a <0.5- 73% chance, assuming a large spill starts at P1-P11. A 180-day period is used in this analysis, because it allows an adequate time period for most winter spills to overlap with summer-use period of most birds in the Kasegaluk Lagoon and Peard Bay areas. The highest percent chance of contact from a launch area occurs at ERA 49, which has a 54% chance of contact from a large spill occurring from LA 7. Environmental resource area 49 is the Hanna Shoal polynya. The chance of contact to this ERA is highest, because the OSRA model's launch area and the ERA are in close proximity to or overlap each other. The greatest percent chance of contact from a pipeline segment spill occurs at ERA 48, which has a 73% chance of contact from a large spill occurring from P8. As with the launch areas, the chance of contact from a pipeline spill to ERA 48 is the highest because the OSRA model pipeline segment and the ERA are in close proximity to or overlap each other.

Many sea ducks must stage offshore in the spring if their breeding habitats are unavailable. Environmental resource areas 21-23 and ERA 24/64 are spring leads (April-June) used by eiders and other sea ducks during spring, and the highest percent chance of a large spills contacting these ERA's is 14% from LA 12. Similarly, spills originating from LA8 and LA13 have a 6% and 8% chance, respectively, of contacting sea ducks staging offshore Barrow in the Plover Islands (LS 85 and LS 86).

Whereas Kasegaluk Lagoon and Peard Bay are important areas during open water in summer and fall, there would be less of a direct risk to birds in these areas during the winter since most birds have migrated elsewhere for the winter and the bays and lagoons are frozen. However, if Peard Bay and Kasegaluk Lagoons were to become oiled in winter, there would likely be effects to the habitat and the birds as they return in spring and begin to forage and breed in these areas. Large spills originating from P6 have a 13% chance of contacting birds in Kasegaluk Lagoon (ERA 1). Large spills originating from P11 have a 12% chance of contacting Peard Bay (ERA 64).

A mitigation measure that could help reduce the extent and impact of large spills involves staging spill-response equipment and bird-rescue gear near a production platform or on shore to avoid delays in transporting this equipment from other oil-production sites on the North Slope (see Sec. IV.C.1.g(5)).

IV.C.1.g(4)(a)3) Chronic Low-volume Spills. Beached bird surveys have demonstrated that small-volume, chronic oil pollution is an ongoing source of mortality in coastal regions (Burger and Fry, 1993). Small volumes of oil may be released from leaking tanks and valves, accidents during loading and offloading, and flushing of tanks and bilges. In cold climates, an oil spot the size of a square inch is enough to compromise water repellency of plumage, possibly leading to the death of a bird. In some places, low-volume, chronic oiling is a major cause of seabird mortality.

Small spills are defined as <1,000 bbl. The average small crude-oil spill size is 113.4 gal (2.7 bbl). An estimated 178 small crude oil spills would occur during the life of the project (Appendix A, Table A.1-29), an average of more than 4 per year. The average refined-oil spill size is 29 gal (0.7 bbl), and an estimated 440 refined-oil spills would occur over the life of the project (Appendix A, Table A.1-32), an average of 11 per year. Overall, an estimated 15 small-volume oil spills would occur each year.

It is unknown how many small-volume spills or what total volume would reach areas used by marine and coastal birds. Chronic low-level spills are not modeled by the OSRA but could adversely affect marine and coastal birds. Although difficult to state with any certainty, a small-volume spill in close proximity to concentrations of marine and coastal birds could result in adverse impacts to pelagic species that tend to forage in dense concentrations. Given the wide distribution of pelagic seabirds, a spill may contact tens of thousands of pelagic birds, if they are foraging in dense concentrations near the spill site or could completely miss them, if they are concentrated in another area. Depending on the chronic nature of small spills, this situation could occur repeatedly.

The location of these small volume spills would be an important factor in assessing impacts. While it is not possible to predict where these spills might occur given the large lease-sale area, important areas known to receive frequent use such as Peard Bay and Kasegaluk Lagoon could be impacted. The bird activity in these areas fluctuates widely based on the time of year and, for many shorebirds, can vary greatly from day to day. For shorebirds in this area, a spill could impact tens of thousands of birds or very few, depending on the time of the spill and the persistence of the oil and its effects. Such areas are considered “hot spots” and although their importance is understood, it is difficult to assess impacts.

IV.C.1.g(4)(b) Effects of Toxics Contamination. Oil activity also may result in increasing contamination of marine habitats due to the disposal of drilling muds and cuttings, or accidental eruption of oil from test wells during a blowout. Such contamination may impact individual birds either through direct contact or indirectly as a result of effects on prey populations or important habitats.

The Proposed Action assumes that 7-14 new wells would be needed to delineate the first production field. An unknown number of production wells would be drilled over the life of the lease sale. A maximum of two drilling rigs would be operable on the platform in any one year. Discharges as a result of these wells are regulated by the USEPA through a NPDES permit. The USEPA has completed Section 7 consultation with the USDO, FWS regarding the likelihood that the proposed discharges associated with exploration and production activities would adversely affect marine and coastal birds.

IV.C.1.g(5) Mitigation Measures.

IV.C.1.g(5)(a) Standard Mitigation Measures Considered in this Analysis. The effects on marine and coastal birds could be moderated by two stipulations, two ITL’s, and other mitigation measures.

Stipulation No. 3, **Transportation of Hydrocarbons**, is described in Sec. II.B.3.c(1). Nearshore resources such as important bird habitats near river deltas or coastal lagoons probably would benefit the most from it. The U.S. spill rate from pipelines is lower than the rate from barges, and this stipulation requires pipeline when feasible. Specifically, 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.

Stipulation No. 7, **Measures to Minimize Effects to Spectacled and Steller’s Eiders during Exploration Activities**, would benefit marine and coastal birds, especially those in the Ledyard Bay Spectacled Eider Critical Habitat Area and the Spring Lead System. These measures address lighting of lease structures/vessels and any exploration or delineation drilling proposed to occur within the Ledyard Bay Critical Habitat Area and the Spring Lead System.

The ITL No. 7, **Information on the Spectacled Eider and Steller’s Eider**, contains information regarding the status these seabirds, their general ecology, and lessee obligations under an incremental step consultation with the USDO, FWS. Conservation measures incorporated into future development projects to avoid jeopardy to listed eider populations or adverse modification of their critical habitat would have direct benefits to coastal and marine birds.

The ITL No. 8, **Sensitive Areas to be Considered in Oil Spill Response Plans**, advises lessees that certain areas are especially valuable for their importance to birds and other biota and should be considered when developing oil-spill-response plans. Identified areas of special biological sensitivity include coastal lagoons, certain freshwater lakes, and areas near seabird colonies. These areas are to be considered in the oil-spill-response plan required by 30 CFR 254.

Section II.B.4.a includes mitigation measures for seismic operations in the Chukchi Sea. These include:

4. Ramp Up - This technique involves the gradual increase (usually 5-6 dB per 5-minute increment) in emitted sound levels, beginning with firing a single airgun and gradually adding airguns over a period of at least 20-40 minutes, until the desired operating level of the full array is obtained. Ramping up

airgun emissions could provide diving birds an opportunity to move away from the noise source, thereby reducing the risk of injury or altered behavior to negligible levels.

7. All bird strikes are to be reported to MMS.
8. Temporal/Spatial/Operational Restrictions:
 - Seismic surveys must not occur in the Chukchi Sea spring lead system before July 1 of each year. . . . Lessees are required to provide information regarding their operations within the spring lead system upon request of MMS. MMS may request information regarding number of vessels and their dates/points of entry into and exit from the spring lead system.
 - No seismic vessel activity, including re-supply vessels and other related traffic, will be permitted within the Ledyard Bay Critical Habitat Area after July 1 of each year, unless human health or safety dictates otherwise. Incursions for human health or safety purposes shall be reported within 24 hours to MMS. Other incursions will be considered non-compliance with this condition.
 - Survey-support aircraft will avoid flying over the Ledyard Bay Critical Habitat Area below an altitude of 1,500 feet (450 meters) after July 1 of each year, unless human health or safety dictates otherwise. Incursions for human health or safety purposes shall be reported within 24 hours to MMS. Other incursions will be considered non-compliance with this condition. In other coastal areas, seismic-survey-support aircraft should maintain at least 1,500 ft (450 m) over beaches, lagoons, and nearshore waters as much as possible.
 - Seismic-survey and support vessels will minimize operations that require high-intensity work lights, especially within the 20-m bathymetric contour. High-intensity lights will be turned off in inclement weather when a vessel is not actively participating in seismic surveys, however, navigation lights, deck lights, and interior lights could remain on for safety.

IV.C.1.g(5)(b) Mitigation Measures Proposed but Not Considered in this Analysis. The following mitigation measures are recommended for exploration activities but were not included in the analysis. Recommendations for production activities could be implemented in the design and NEPA review of a future development project

Seismic Operations:

- Validate response of diving birds to seismic vessel approach.
- Designate flight routes for when aircraft cannot maintain 1,500 ft ASL, especially around the Ledyard Bay Critical Habitat Area, after July 1 of each year.

Production Activities:

- Identify high-value bird staging/breeding/feeding/molting habitats; implement avoidance criteria.
- Avoid increasing predator populations.
- Prestage spill-response, bird rescue, and at-sea hazing equipment.
- Construct and maintain facilities during winter.
- Designate aircraft and vessel routes.

IV.C.1.g(6) Anticipated Impacts of the Proposed Action to Marine and Coastal Birds. The potential effects on marine and coastal birds depend on the timing of activities, the location and activity of birds, and the sensitivity of each bird species. Based on available data, birds in the proposed lease sale area were divided into two groups: those with a higher potential for substantial effects and those with a lower potential for substantial effects.

IV.C.1.g(6)(a) Birds with a Higher Potential for Substantial Effects. Murres. Murres forage over a wide area of the Chukchi Sea during the breeding season and cover a much larger area later in the summer and fall when juveniles are floating flightless at sea during their at-sea rearing period. Attendant males are completely flightless at molt during the same period. The greatest source of potential impacts to common and thick-billed murres occurs from potential oil-spill impacts at breeding colonies and to adult males and juvenile birds during the pelagic flightless period.

The potential effects of an oil spill are greater with murre than most other marine and coastal bird species because a spill could impact discrete colonies, namely those at Cape Lisburne and Cape Thompson (Piatt and Anderson, 1996). There is a 58% chance that spilled oil would contact ERA 15, directly adjacent to the murre breeding colonies near Cape Lisburne, during the May-October open-water period. Murre also breed at Cape Thompson (ERA 14), where there is a 51% chance that spilled oil would contact birds near the colony during the May-October open-water period. Foraging bouts from the breeding colonies can range more than 100 km (60 mi) from shore (Fig. III.B-7).

Foraging adults could be killed if contacted by oil and may not make it back to the colony to incubate the egg or provision their chick. Adults may return to the nest only to cover the egg or chick in oil carried on their feathers. The abundance of prey items could be reduced or contaminated with oil, resulting in impacts to murre, even if they are not directly exposed to oil. Murre also may incur sublethal effects and either die at a later date or fail to breed in future years due to immuno-suppression or reduced fitness. All sex- and age-classes of murre could be affected. Given that murre are long-lived birds with low reproductive rates, recovery from mortality associated with an oil spill would likely take more than three generations to occur. Abundance at colonies could be reduced for 15 years or longer.

Thompson et al. (2003) summarized some of these effects when evaluating a murre colony restoration project in coastal Washington State following the *Tenyo Maru* oil spill that impacted tens of thousands of murre:

As is typical of many seabird species, murre display a long-lived, low fecundity life history strategy (Gaston and Jones 1998, Nettleship and Birkhead 1985, Tuck 1961). In these species, population growth (λ) is classically highly sensitive to minute changes in adult mortality (Nur and Sydeman 1999), although persistent exaggerated depression of reproductive output can also depress population growth (Parrish et al. 2001). In addition, murre are natively philopatric (Harris et al. 1996) - although straying does occur (Friesen et al. 1996) - a trait which would tend to accentuate the impacts of local mortality sources. Thus, small scale oil spills, or other mortality events, might be expected to differentially affect local colonies, especially during the breeding season when experienced adult breeders are most highly concentrated in the area.

Similarly, juvenile murre and attendant males are particularly at risk while they are pelagic and flightless and unable to rapidly move out of the area affected by a spill in the open sea. If murre are concentrated at foraging sites, many murre could be affected at once. There is a 42% chance that a large spill would contact this area (ERA 18, Map A.1-2a) during the May-October open-water period (from LA 9 within 180 days following a summer spill, Table A.2-29). There is a 37% chance that a large spill from P1 would contact ERA 18 under the same conditions. The adverse population impacts from this event would be somewhat less than those at the breeding colonies, because breeding females would not be in ERA 18; but it is possible that a large percentage of the hatching-year cohort could be lost as well as their attendant male parents.

Puffins. Puffins forage over a wide area of the Chukchi Sea during the breeding season and cover a much larger area later in summer. Unlike murre, puffin-foraging areas are not specifically delineated. Most postbreeding puffins are located near Cape Lisburne in September. The greatest source of potential impacts to puffins occurs from potential oil-spill impacts at breeding colonies.

Horned puffins and, to a lesser extent, tufted puffins, could be affected by a large oil spill or chronic, small-volume spills. Foraging adults could be killed if contacted by oil and may not make it back to the colony to incubate the egg or provision their chicks. Adults may return to the nest only to cover the eggs or chicks in oil carried on their feathers. The abundance of prey items could be reduced or contaminated with oil, resulting in impacts to puffins, even if they are not directly exposed to oil. Puffins also may incur sublethal effects and either succumb at a later date or fail to breed in future years due to immuno-suppression or reduced fitness. Given that puffins are long-lived birds with low reproductive rates, effects of a spill from 1 year could affect abundance at colonies for several years. All sex- and age-classes of puffins could be affected. Recovery from mortality associated with an oil spill likely would take more than three generations to occur. Abundance at cliff colonies could be reduced for 15 years or longer.

The potential effects of an oil spill are greater with less-abundant tufted puffins than horned puffins, because a spill could impact discrete colonies at Cape Thompson and Cape Lisburne. The tufted puffin is an obligate cliff nester. A large spill could affect widely scattered puffin colonies located along barrier islands along the Chukchi Sea coast. Horned puffins can breed on suitable beach habitat on islands near shore by digging burrows or hiding under large pieces of driftwood or debris. Given the distribution of these colonies, population recovery could occur from surrounding colonies once oiled beach habitats are restored.

Short-tailed Shearwaters and Auklets. These seabirds are considered together, because they occur in similar numbers, and both forage on patchily distributed zooplankton in pelagic waters.

Large numbers of shearwaters or auklets could be harmed by collisions with seismic vessels and exploration and development structures. Large-scale collision events involving crested auklets and high-intensity lights on commercial fishing vessels have been documented. Dick and Donaldson (1978) documented 1.5 metric tons of crested auklets striking and nearly capsizing a fishing vessel. Collisions are not documented for shearwaters, but these types of events typically are poorly documented. Large flocks of shearwaters and auklets are present in the Chukchi Sea until late September or early October when there are about 12 hours of darkness and limited visibility due to fog and inclement weather.

The nonuniform distribution of these species could favor their survival during an oil spill or lead to extensive mortality. Given their large-scale movements and flocking behavior (Shuntov, 1999), auklets and shearwaters could experience extensive mortality if large aggregations come in contact with spilled oil. In a worst-case scenario, as many as 100,000 auklets and 100,000 shearwaters could be exposed to oil, if the spill covered a large area and the birds were in large groups. The abundance of prey items could be reduced or contaminated with oil, resulting in impacts to shearwaters and auklets, even if they are not directly exposed to oil.

Given this uncertainty, the most likely anticipated impact is that up to 10,000 auklets and/or shearwaters would be killed during a large oil spill. This would be an adverse impact to the regional population, but recovery would likely occur in fewer than three generations.

Black Guillemot. These birds usually are closely associated with the ice edge. Impacts to black guillemots by oil spills could be extensive, if a spill occurred when the ice edge was in close proximity to the spill location. Foraging adults could be killed if contacted by oil and may not make it back to the colony to incubate the eggs or provision their chicks. Oiled adults may return to the nest only to cover the eggs or chicks in oil carried on their feathers. The abundance of prey items could be reduced or contaminated with oil, resulting in impacts to black guillemots, even if they are not directly exposed to oil. Black guillemots also may incur sublethal effects and either die at a later date or fail to breed in future years due to immuno-suppression or reduced fitness.

The population of black guillemots in the Chukchi is not very large but appears to be widely dispersed. Specific breeding colonies on barrier islands could experience extensive mortality, but recovery from surrounding colonies would be expected to occur in fewer than three generations once oiled habitats had recovered.

Loons. Loons using the Chukchi Sea typically migrate close to shore until they are south of Cape Lisburne, when they travel over pelagic waters on their migration to wintering areas. Loons using nearshore areas could be affected by vessels and low-flying aircraft associated with seismic-survey and exploration drilling activities.

The yellow-billed loon is highly vulnerable to environmental change compared to most waterfowl. Patchy distributions and specific habitat requirements may make yellow-billed loons more susceptible to environmental perturbations such as disturbance, habitat alterations, and oil spills than more abundant and widely distributed species that are able to exploit a greater diversity of habitats (Hunter, 1996). Yellow-billed loons in the Chukchi Sea are at particular risk due to their low numbers and low reproductive rate. The species is little studied and basic biological information (such as the seasonal distribution of immature and non-breeding yellow-billed loons) is unknown. Additional research could improve our understanding

of the vulnerabilities of the yellow-billed and other loons using nearshore areas of the Chukchi Sea and western Beaufort Sea.

Loons, and particularly yellow-billed loons, could be affected by habitat loss due to construction of onshore facilities, pipelines, and roads. Oil spills in freshwater nesting and broodrearing lakes, on rivers or streams, or in the marine environment could directly kill or injure birds or contaminate habitats and prey items (CBD, 2004d). Extensive loon nesting habitat surveys and detailed layout of pipeline and maintenance road routes might help avoid most adverse effects of loon-nesting-habitat loss.

A large spill could affect nearshore areas used by nonbreeding loons or, later in the open-water season, loon broods. Depending on the spill timing, trajectory analysis, and locations of offshore loons, a large proportion of any sex-age class could experience extensive mortality. Extensive mortality of certain sex-age classes could contribute to immediate or gradual population-level impacts, including the large-scale loss of the yellow-billed and other loons on the Arctic Slope.

Long-Tailed Duck. Disturbance impacts to long-tailed ducks from seismic surveys would be lowest during the postbreeding molting period, because most birds are concentrated in coastal lagoons along the Chukchi Sea. Long-tailed ducks could be affected by vessels and low-flying aircraft associated with seismic-survey and exploration drilling activities.

After the molt period, long-tailed ducks move south following the Chukchi Sea coast and typically remain 45 km (27 mi) offshore along the 20-m isobath, where they could be disturbed by vessel activity from seismic vessels, drillships, and activities at production platforms (Fig. III.B-6). The eastern boundary of the lease-sale area overlays the 20-m isobath frequently followed during fall migration by long-tailed ducks and several other species of waterfowl. Long-tailed ducks are uncommon further offshore.

Seismic vessels using high-intensity work lights could pose a threat to long-tailed ducks, if the vessels were operating in migratory paths in darkness or inclement weather. The risk of collisions with seismic-survey vessels would be highest when these vessels are in the area of the 20-m isobath during fall migration. The risk of collisions with drill ships and production platforms is lower, because the proposed lease-sale area boundaries are farther offshore than known migration pathways for long-tailed ducks.

Long-tailed ducks could experience extensive mortality if a large oil spill contacted important duck habitats. The worst-case scenario involves a spill that would reach into Peard Bay or Kasegaluk Lagoon. Spills originating from P11 have a 56% chance of contacting birds in Peard Bay during the May-October open-water period. If recent numbers of long-tailed ducks using Peard Bay are similar to those in the early 1980's documented by Kinney (1985), as many as 7,000 birds could be impacted by spilled oil.

Spills originating from P6 have a 34% chance of contacting birds in Kasegaluk Lagoon during the May-October open-water period. If recent numbers of long-tailed ducks using Kasegaluk Lagoon are similar to those in the early 1990's documented by Johnson, Wiggins, and Wainwright (1992), as many as 9,000 birds could be impacted by spilled oil.

Long-tailed ducks could suffer direct or indirect mortality, if they are contacted by oil or inhale vapors. The abundance of prey items could be reduced or contaminated with oil, resulting in impacts to long-tailed ducks even if they are not directly exposed to oil. Long-tailed ducks also may incur sublethal effects and either die at a later date or fail to breed in future years due to immuno-suppression or reduced fitness. Mortality of 7,000-9,000 long-tailed ducks could represent a significant adverse impact, if recovery does not occur within three generations.

Common Eider. Common eiders molt near several locations along the Alaska Chukchi Sea coast, including Point Lay, Icy Cape, and Cape Lisburne. As with other eiders, the common eider probably molts in locations having high-density prey items. Disturbance at molt locations from vessel traffic and low-flying aircraft could impose additional stress during this energetically demanding period.

Most common eiders follow the 20-m isobath, which is ~45 km (27 mi) from shore in the Chukchi Sea (Fig. III.B-8). Seismic vessels using high intensity could pose a threat if the vessels were operating in migratory paths in darkness or inclement weather. The risk of collisions with seismic-survey vessels would

be highest when these vessels are in the area of the 20-m isobath during fall migration. However, the risk of collisions would decrease markedly, if vessels were located well outside typical migration pathways. The risk of collisions with drillships and production platforms would be lower, because the proposed lease-sale area boundaries are farther offshore than known migration pathways for common eiders.

Impacts from an oil spill could be extensive. The worst-case scenario involves a spill that would reach into Kasegaluk Lagoon or Peard Bay. Spills originating from P6 have a 34% chance of contacting birds in Kasegaluk Lagoon during the May-October open-water period. If recent numbers of common eiders using Kasegaluk Lagoon are similar to those in the early 1990's documented by Johnson, Wiggins, and Wainwright (1992), as many as 2,000 birds could be impacted by oil. Spills originating from P11 have a 56% chance of contacting birds in Peard Bay during the May-October open-water period. If recent numbers of common eiders using Peard Bay are similar to those in the early 1980's documented by Kinney (1985), as many as 4,000 birds could be impacted by oil.

Additionally, common eiders that breed on barrier islands along the Chukchi Sea coast could be impacted by spilled oil. During a 2005 aerial survey conducted in late June to coincide with the common eider egg-laying and early incubation period, 742 common eiders were observed along the Chukchi Sea coast between Omalik Lagoon and Point Barrow. Most common eiders were observed in Kasegaluk Lagoon and Peard Bay (Dau and Larned, 2005). The number of birds that could be affected at sea during spring or fall migration is unknown.

Common eiders could suffer direct or indirect mortality, if they are contacted by oil or inhale vapors. The abundance of prey items could be reduced or contaminated with oil, resulting in impacts to long-tailed ducks even if they are not directly exposed to oil. Long-tailed ducks also may incur sublethal effects and either die later or fail to breed in future years due to immuno-suppression or reduced fitness.

Although reduced from population levels of the mid-1970s, the number of Pacific Race common eiders nesting in Western Canada was crudely estimated to be 68,000; another 3,000 nest along the Alaska Beaufort Sea coast (Sea Duck Joint Venture, 2003). In the event of a large oil spill, as many as several hundred common eiders breeding on offshore barrier islands of the Arctic Coastal Plain could experience extensive mortality. Recovery from the larger population would be expected to occur in fewer than three generations (once oiled habitats had recovered) if the population trend continued to be stable.

King Eider. Impacts to king eiders would be similar to common eiders in the Chukchi Sea, except that king eiders molt at locations in the Bering Sea. Migration distances from shore are similar, so the collision risks would be the same as for common eiders. King eiders tend to occur farther offshore in greater concentrations of broken ice. These areas would be closer to potential sites of a development platform, and king eiders would be contacted more quickly by an oil spill originating offshore than birds closer to shore. King eiders have been observed in Peard Bay and, though their abundance is unknown, it probably is less than common eiders based on surveys in the early 1980's by Kinney (1985). The effects of oil exposure would be similar to common eiders, but the number of birds affected likely would be less in Peard Bay and Kasegaluk Lagoon. The number of birds that could be affected at sea during spring or fall migration is unknown.

Although reduced from population levels of the mid-1970s, the king eider population in the nearby Beaufort Sea remains relatively large and has a significantly positive long-term (14 year) growth rate. A large spill could result in mortality to hundreds of king eiders. Recovery from the larger population would be expected to occur in fewer than three generations (once oiled habitats had recovered), if the long-term population trend continued.

Black-Legged Kittiwake. If Divoky's (1987) estimate of 400,000 black-legged kittiwakes in pelagic waters accurately represents the current situation, impacts to these birds could be extensive and in many ways similar to shearwaters and auklets. However, kittiwakes in pelagic waters may be at less of a risk if they are more widely distributed than shearwaters and auklets, because a spill would be less likely to affect a large proportion of the kittiwakes in the Chukchi Sea. The portion of Chukchi Sea kittiwakes in the proposed lease-sale area is unknown. Seasonal areas of concentration, if any, are unknown.

The potential effects of oil spills to kittiwakes likely would be similar to other seabirds nesting at Cape Thompson and Cape Lisburne. If as many kittiwakes nest in these areas as did between 1960 and the late 1970's (Sowls, Hatch, and Lensink, 1978), as many as 48,000 nesting kittiwakes could be affected. Current population estimates at these colonies are unknown.

Pacific Brant. Pacific brant could be affected by a number of activities resulting from the proposed lease sale. The greatest risks of negative impacts are from disturbance from low-flying aircraft and risk of contact from a large oil spill reaching Kasegaluk Lagoon, an important molting area. Other important molting areas include Peard Bay and Ledyard Bay.

Brant use Kasegaluk Lagoon as a stopover location during postbreeding migration from late June through August. Johnson, Wiggins, and Wainwright (1992) observed more than 63,000 black brant in late August in 1989. As much as 45% of the estimated Pacific Flyway population was present at one time in Kasegaluk Lagoon in late August (Johnson et al. (1992). A large oil spill originating from P6 would have a 34% chance of contacting brant in Kasegaluk Lagoon during the May-October open-water period. Impacts could range from direct mortality, if brant were present during a spill or indirect mortality, if they used the lagoon long after a spill but ingested oil while foraging or had less foraging habitat available. Impacts to habitat in Kasegaluk Lagoon or other molting areas could persist for a number of years and continue to affect brant for a long time after the spill (see Sec. IV.C.1.j(4)(e) Vegetation and Wetlands).

The loss of as much as 45% of the Pacific Flyway population of brant would be a significant adverse impact. Recovery would take more than three generations to occur, if it would occur at all.

Phalaropes. Phalaropes are most abundant in the Chukchi Sea during the postnesting period in late summer and fall. Phalaropes use habitat within a few meters of shore, especially Peard Bay and Kasegaluk Lagoon, and also pelagic areas where they forage on patchy concentrations of zooplankton. Phalaropes could be disturbed in Peard Bay and Kasegaluk Lagoon by low-flying aircraft.

Collisions with vessels or structures are a possibility. Lambert (1988) reported that red-necked phalaropes were attracted to lights on a ship in the Gulf of Guinea and reacted most strongly at night in inclement weather. There do not appear to be any other documented cases of collisions involving phalaropes, so the incidence of collisions may either be low or unreported.

Phalaropes were one of the key species groups of shorebirds which utilized Kasegaluk Lagoon and Peard Bay, where they stage or stopover in nearshore marine and lacustrine waters (Alaska Shorebird Working Group, 2004). Oil spills pose the greatest risk to phalaropes using Peard Bay and Kasegaluk Lagoon. In addition to direct mortality from contact with oil, phalaropes could be affected by ingesting contaminated prey or by decreased prey concentrations. If oil contaminated or decreased prey species, phalaropes could be affected long after the oil spill reached important habitat areas.

Reliable estimates of the number of phalaropes using these two locations are unavailable; however, given the high variability in shorebird abundance at migration stopover sites, an oil spill could negatively affect either very few or almost every phalarope using an area, depending on when the spill occurred. Phalarope populations appear stable. A large spill could result in mortality to hundreds of phalaropes. The loss of hundreds of phalaropes would be considered an adverse but not significant impact, and population recovery would likely occur in fewer than three generations (once oiled habitats had recovered) if the population trend continued to be stable. If this magnitude of mortality were exceeded, then a significant adverse impact would occur and population recovery would likely take much longer.

Lesser Snow Goose. There are very few lesser snow geese nesting in Alaska. This species nests on an island in the Kukpowruk River delta (about 60 km south of Point Lay) in the southern portion of Kasegaluk Lagoon. Snow geese at this nesting area could be disturbed by low-flying aircraft. An oil spill contacting this area could eliminate one of two consistently occupied nesting colonies for lesser snow geese in the U.S. The loss of this breeding colony would not only constitute a significant impact, but it would increase the importance and vulnerability of the lesser snow goose population at the remaining U.S. colony near Prudhoe Bay.

Lesser snow geese are more widely distributed in Canada and Wrangel Island. During the 1990's, the midcontinental snow goose population increased. They are nesting in such high concentrations in some parts of Arctic Canada that they are stripping the tundra of the very vegetation that they need to survive. Biologists are concerned that their population may crash from disease and/or the damage they are causing to the Arctic tundra.

IV.C.1.g(6)(b) Birds with a Lower Potential for Substantial Effects. Northern Fulmar. Most fulmars are present only outside the proposed lease-sale area in the southern portions of the Chukchi Sea for a few weeks at the end of summer, so the likelihood of large-scale impacts is minimal.

Gulls and Terns. Ross's gulls and ivory gulls are ice-associated birds and breed well outside the lease-sale area. They are present in the proposed lease-sale area for a short period before migrating through the Chukchi Sea to overwintering locations. Terns migrate through the Chukchi Sea but are rarely observed in pelagic waters. Similarly, glaucous gulls typically are most abundant within 70 km (42 mi) of shore, thereby reducing the likelihood of disturbance and collisions. Due to their limited distribution, impacts from oil spills are less likely than many other species of marine and coastal birds.

Jaegers. Jaegers are present throughout the Chukchi Sea, but are not known to occur in high concentrations. The chance of impacts to large numbers of jaegers is minimal.

Other Waterfowl and Shorebirds Impacts on many species of waterfowl and shorebirds are anticipated to be relatively low, but there are some key areas of vulnerability where they could be at risk of effects from exploration and production.

A relatively small number of nesting tundra swans could be affected by an oil spill in Kasegaluk Lagoon, because flightless young-of-the-year birds were observed in 1990 and 1991 by Johnson, Wiggins, and Wainwright (1992). Tundra swan nests could be impacted by the pipeline alignment on the tundra. Extensive tundra swan-nesting surveys and implementation of buffer zones could reduce potential negative effects on swans.

More than 4,000 greater white-fronted geese have been observed in Kasegaluk Lagoon during a single aerial survey (Johnson, Wiggins, and Wainwright, 1992). A large oil spill contacting Kasegaluk Lagoon during their period of occupancy could directly affect these geese and a spill at other times of the year could lead to ingestion of contaminated food resources. Oil spills also could decrease abundance of food resources.

Dunlins are another prominent species in Kasegaluk Lagoon and Peard Bay in late summer and fall. As with other species of shorebirds and waterfowl, a spill during periods of peak abundance could impact large numbers of dunlins. Less is known about the numbers, timing, and patterns of habitat use of Kasegaluk Lagoon and Peard Bay by bar-tailed godwits but, given their recent population declines, effects of an oil spill could be particularly important.

There appear to be coastal sites where large numbers of shorebirds could come into close contact with an oil spill. In the nearby Beaufort Sea, for example, the Colville River Delta hosts between 41,000 and 300,000 shorebirds between July 25 and September 5 (Andres, 1994; USDOJ, FWS, 2004a). The range of these numbers depends upon how long birds remain in the area before migrating (Andres, 1994; Powell, Taylor, and Lanctot, 2005; Taylor et al., 2006). Results on bird tenure times from the Taylor et al. (2006) project may help clarify the anticipated range of shorebirds using the delta. At the present time, it appears that large numbers of shorebirds could be affected during this important postbreeding period through oil exposure and subsequent hypothermia, should they encounter oil on shorelines, or indirectly by birds eating contaminated prey or their invertebrate food sources dying (USDOJ, FWS, 2004a). Coastal sediments and invertebrates could remain affected by oil for extended periods. The FWS states that disturbances such as these could have population-level effects, because large numbers of shorebirds could be affected (USDOJ, FWS, 2004a). More survey work is needed to fully evaluate the vulnerability of dunlins and other shorebirds using coastal areas of the Chukchi Sea to proposed lease-sale activities.

American golden plovers would be expected primarily on the tundra, but they could be impacted by a terrestrial oil spill as well as disturbance and habitat loss. The North American population of this species is

considered a species of high concern (USDOJ, FWS, 2004b), so even small sources of mortality could have a large population effect.

Raptors. Raptors may extend their range if they were able to nest on oil-development and -transportation structures. While this range expansion may benefit raptors, it likely would have a net negative impact on other marine and coastal birds because these birds would suffer increased predation. Anticipated impacts to raptors from an oil spill likely would be minimal, but some raptors may be impacted if they were to feed on oiled carcasses.

Potential negative impacts associated with design and construction of shore-based pipelines and roads would be evaluated under a future NEPA document, once marketable quantities of oil are proposed for development and production.

Conclusion. Marine and coastal birds could be exposed to a variety of potential negative effects during seismic surveys, exploration drilling, and production including disturbances, collisions, habitat loss, petroleum exposure, and exposure to toxic contamination. The greatest potential for substantial adverse impacts typically would arise from collisions, aircraft disturbance, and large and chronic low-volume spills in important coastal bird habitats. These areas are Kasegaluk Lagoon, Ledyard Bay, Peard Bay, barrier islands, the spring open-water lead system, and the seabird-nesting colonies at Cape Lisburne and Cape Thompson. Despite the importance of these areas, as well as the entire Chukchi Sea within the proposed lease-sale area, little recent site-specific data are available on habitat-use patterns, routes, and timing to assess impacts. For many species, the most recent data are between 15 and 30 years old, making accurate analysis difficult. Because of this long data gap, it is unknown if population abundance or distribution of many species have changed.

Oil spills have the greatest potential for affecting large numbers of birds in part due to its toxicity to individuals and their prey and the difficulties involved in cleaning up spills in remote areas, given the wide variety of possible ice conditions. A large spill could impact large number of murres, puffins, and kittiwakes at the Cape Lisburne and Cape Thompson colonies. The magnitude of potential mortality could result in significant adverse impacts to the colonies. Similarly, large-scale mortality could occur to pelagic distributions of auklets and shearwaters during the open-water period and male and juvenile murres in the late summer.

Kasegaluk Lagoon, Peard Bay, colonies at Cape Thompson and Cape Lisburne, the open-water Spring-Lead System, Ledyard Bay, and barrier islands provide important nesting, molting, and migration habitat to a variety of waterfowl and shorebirds. Spills during periods of peak use could affect large numbers of birds. As a typical example, up to 45% of the estimated Pacific Flyway population of Pacific brant could be affected, if an oil spill reaches Kasegaluk Lagoon. Effects could range from direct mortality of approximately 60,000 brant to sublethal effects on an equal or smaller number of brant. The loss of up to 45% of the Pacific Flyway population would have conspicuous population-level effects. The situation with brant is similar to a wide variety of waterfowl and shorebirds that use similar areas of the Chukchi Sea.

IV.C.1.h. Other Marine Mammals.

This section assesses the effects on nonendangered and nonthreatened marine mammals as a result of the Proposed Action (Alternative I).

IV.C.1.h(1) Conclusion. Based on the paucity of information available on marine mammal ecology, and specifically on habitat use patterns, in the Chukchi Sea and based on the lack of specific information regarding the location of future developments, we are unable to determine at this time if significant impacts would or would not occur to marine mammal populations in the project area as a result of the Proposed Action. However, significant impacts could occur to belugas, polar bears, and walrus in the event of a large oil spill.

Careful mitigation can help reduce the effects of future industrial developments and their accumulation through time. However, the effects of full-scale industrial development of the waters of the Chukchi Sea likely would accumulate through displacement of marine mammals from their preferred habitats, increased mortality, and decreased reproductive success. Because of the lack of data on which to base informed

decisions, it is unknown if noise introduced into the environment from industrial activities, including drilling and seismic operations, will have an adverse impact on nonendangered and nonthreatened marine mammals in the Proposed Action area. Increasing vessel traffic in the Northwest Passage, defined as the marine route between the Pacific and Atlantic oceans through the Arctic Ocean across the top of North America, which includes the Proposed Action area, increases the risks of oil and fuel spills and vessel strikes of marine mammals.

IV.C.1.h(2) Effects from 3D/2D Seismic Surveys.

Phocids (Ringed, Spotted, Ribbon, and Bearded Seals). Pinnipeds use the acoustic properties of sea water to aid in navigation, social communication, and possibly predator avoidance. Most phocid seals spend >80% of their time submerged in the water (Gordon et al., 2004); consequently they will be exposed to sounds from seismic surveys. Few studies of the reactions of pinnipeds to noise from open-water exploration have been published. Temporary threshold shift (TTS) values for pinnipeds exposed to brief pulses (either single or multiple) of underwater sound have not been measured.

Phocids have good low-frequency hearing; thus it is expected that they will be more susceptible to masking of biologically significant signals by low frequency sounds, such as from seismic surveys (Gordon et al., 2004). Masking of biologically significant sounds by anthropogenic noise is equivalent to a temporary loss of hearing acuity. Brief, small-scale masking episodes might, in themselves, have few long-term consequences for individuals or populations of marine mammals. However, the consequences might be more serious in areas where many surveys are occurring simultaneously. Underwater audiograms for phocids suggest that they have very little hearing sensitivity below 1 kHz; they can hear underwater sounds at frequencies up to 60 kHz; and make calls between 90 Hz and 16 kHz (Richardson et al. 1995a). While seismic surveys can contain energy up to 1 kHz, most of the emitted energy is <200 Hz. There is considerable variability in the vocalizations of seals, and many of the arctic species vocalize underwater in association with territorial and mating behaviors. Seismic surveys are unlikely to have significant impacts (e.g., masking) on vocalizations associated with breeding activity due to the time of year that surveys will occur (i.e. after the breeding season).

Reported seal responses to seismic surveys have been variable and often contradictory, although they do suggest that pinnipeds frequently do not avoid the area within a few hundred meters of operating airgun arrays. However, Brueggeman et al. (1991) reported that 96% of the seals they encountered during seismic operations in the Beaufort Sea were encountered during nondata acquisition activities, suggesting avoidance of active data acquisition operations. Miller et al. (2002) reported that on average, seals sighted during active seismic periods in the Beaufort Sea were significantly farther from the vessel (210 m) than those sighted during periods without airgun operations (150 m). At the 210-m distance, seals would have been exposed to sound levels of about 190 dB re 1 μ Pa (rms). Sighting rates of ringed seals from another seismic vessel in the Beaufort Sea showed no difference between periods with the full array, partial array, or no guns firing (Harris, Miller, and Richardson, 2001). Mean distances to seals sighted did increase during full array operations, however, suggesting some local avoidance at levels between 190 and 200 dB rms. By contrast, telemetry work by Thompson et al. (1998) (as cited in Gordon et al., 2004) suggests that avoidance and behavioral reactions to small airgun sources may be more dramatic than ship-based visual observations indicate. Instrumented gray (*Halichoreus grypus*) and harbor seals exhibited strong avoidance behavior of small airguns, swimming rapidly away from the seismic source. Many ceased feeding, and some hauled out, possibly to avoid the noise. The behavior of most of the seals seemed to return to normal within 2 hours of the seismic array falling silent. The authors suggest that responses to more powerful commercial arrays might be expected to be more dramatic and occur at greater ranges.

Seals may be disturbed by vessel traffic and aircraft associated with seismic surveys. Disturbance may cause seals to leave haulout locations and enter the water. However, there are few published studies addressing pinniped responses to vessels and aircraft (Richardson et al., 1995a). Jansen et al. (2006) reported that harbor seals approached by ships at 100 m were 25 times more likely to enter the water than were seals approached at 500 m. However, they also reported that seal abundance in Disenchantment Bay, Alaska steadily increased during the summer in concert with increasing ship traffic (i.e., no short-term avoidance of areas used by ships), suggesting that changes in overall abundance were influenced by other factors. Harbor seals in their study area did aggregate more closely with increasing ship presence, similar to studies of other marine mammals that show denser aggregations during periods of disturbance. Born et

al. (1999) reported that the probability of hauled out ringed seals responding to aircraft overflights with escape responses was greatest at lateral distances of <200 m and overhead distances <150 m. Such responses most likely would be relatively minor and brief in nature.

It is uncertain how seismic surveys potentially might impact seal-food resources in the immediate vicinity of the survey. As previously discussed in the seismic-survey PEA (USDOI, MMS, 2006a), direct and adverse impacts affecting some prey species (i.e., some teleost fishes) may last for days to weeks (e.g., displacement from foraging, staging, or spawning habitat areas) or longer (i.e., auditory and/or vestibular harm that lasts months or even years). If seismic surveys cause pinnipeds' prey to become less accessible, either because they move out of an area or become more difficult to catch, than pinniped distributions and feeding rates are likely to be affected. Newly weaned phocid pups may be particularly vulnerable to reduced feeding rates (Gordon et al., 2004) and, thus, may be disproportionately affected by seismic surveys. This is particularly pertinent considering that most phocid pups are weaned in June, just prior to the seismic-survey season in the Chukchi Sea. Conversely, damaged or disoriented prey could attract pinnipeds to seismic-survey areas, providing short-term feeding opportunities but increased levels of exposure (Gordon et al., 2004).

There is no specific evidence that exposure to pulses of airgun sound can cause permanent threshold shift (PTS) to the hearing of any marine mammal, even with large arrays of airguns. Direct impacts causing injury (Level A) from the seismic surveys likely would occur if animals entered the 190-dB zone immediately surrounding the sound source. A marine mammal within a radius of 100 m around a typical array of operating airguns might be exposed to a few seismic pulses with levels >205 dB, and possibly more pulses if the animals moved with the seismic vessel. Although it is unlikely that airgun operations during most seismic surveys would cause PTS in marine mammals, caution is warranted given the limited knowledge about noise-induced hearing damage in marine mammals. However, with appropriate mitigation measures in place (e.g., marine mammal observers and shutdown procedures), the probability of seismic-survey-generated injuries should be mitigated.

Pacific Walrus. For purpose of our analyses we make the following explicit assumptions regarding proposed activities:

We assume that monitoring and mitigating measures similar to those required by previous authorizations (Sec. II.B.4) related to the protection of walrus and their continued availability to subsistence hunters would be put in place for future exploration activities. Mitigation measures are expected to include vessel-based and/or site-specific monitoring programs intended to avoid interactions with walrus groups and monitor their response to ongoing activities; establishment of operational buffer zones around observed animals for seismic vessels intended to reduce incidences of hearing damage; and establishment of operational buffer zones around walrus groups for vessels and aircrafts intended to reduce disturbance events.

Additionally, we assume that the FWS annually will review site-specific operational plans as well as the results of previous monitoring efforts to formulate site-specific mitigation measures. These measures would be incorporated as operational stipulations in a Letter of Authorization (LOA).

During seismic exploration, human-caused noise is generated from a variety of sources including, but not limited to, the seismic impulses purposely released into the water; icebreakers; other ships and boats; and helicopter and fixed-winged aircraft traffic. Noise and associated disturbances potentially could interfere with walrus' ability to function normally and on their health. Increased noise levels in the environment have the potential to interfere with communications, mask important natural sounds, cause physiological damage, or alter normal behavior such as causing avoidance behavior that keeps animals from a biologically important area or interrupts migration routes. Behavioral reaction to noise or other disturbance stimuli also can cause animals to flee a land or ice haulout en masse, potentially causing physical injuries or mortalities. The potential for a given sound to cause adverse effects to Pacific walrus is expected to be habitat dependent. The exact location of any sound source would determine the fate of sound released at that site and would affect the possibility of impact on walrus in or near the area. The time of year a sound is released would determine whether there is potential for individual walrus to be exposed to that sound.

Potential impacts to female walrus and dependent calves are a major concern. Oil and gas activities that occur during ice-minimum conditions in summer in the Chukchi Sea are likely to come into direct contact with adult females and subadult walrus (Jay et al., 1996). If disturbance causes walrus to abandon preferred feeding areas or interferes with calf-rearing, resting, or other activities, then the walrus population could be negatively affected. Walrus will flee haulout locations in response to disturbance from aircraft and ship traffic, although reactions are highly variable (Richardson et al., 1995a). Females with dependent young are considered the least tolerant of disturbances, and walrus in the water are thought to be more tolerant to disturbance stimuli than those hauled out. Helicopters are more likely to elicit responses than fixed-wing aircraft, and walrus are particularly sensitive to changes in engine noise and are more likely to stampede when aircraft turn or bank overhead. Researchers conducting aerial surveys for walrus in sea-ice habitats have reported little reaction to aircraft above 1,000 ft (305 m). The reaction of walrus to vessel traffic appears to depend on vessel type, distance, speed, and previous exposure to disturbances. Other factors, such as weather and length of time hauled, also may contribute to the response. Brueggeman et al. (1991) reported that 81% of walrus encountered by vessels in the Chukchi Sea exhibited no reaction to ship activities within less than a kilometer, which suggests that walrus may be tolerant of ship activities and movements. However, ice-management operations are expected to have the greatest potential for disturbances to walrus. For example, Brueggeman et al. (1991) reported that walrus moved 20-25 km from active icebreaking operations, where noise levels were near ambient. Conversely, researchers onboard an icebreaker during ice-management operations observed little or no reaction of hauled out walrus groups beyond 0.5 mi (805 m) of the vessel (Garlich-Miller, 2006, pers. commun.). Potential effects of prolonged or repeated disturbance include displacement from preferred feeding areas, increased stress levels, increased energy expenditure, masking of communication, and the impairment of thermoregulation of neonates that are forced to spend too much time in the water (Garlich-Miller, 2006, pers. commun.).

Seismic operations are expected to create significantly more noise than general vessel and icebreaker traffic; however, there are no data available to evaluate the potential response of walrus to seismic operations. Marine mammal-monitoring programs are expected to provide some insight to the response of walrus to various seismic operations from which future mitigative recommendations can be made.

Disturbances caused by vessel and air traffic may cause walrus groups to abandon land or ice haulouts. Severe disturbance events could result in trampling injuries or cow-calf separations, both of which are potentially fatal. Open-water seismic exploration produces underwater sounds, typically with airgun arrays.

Walrus produce a variety of sounds (grunts, rasps, clicks), which range in frequency from 0.1 Hz-10 Hz (Richardson et al., 1995a). Quantitative research on the sensitivity of walrus to noise has been limited because no audiograms (a test to determine the range of frequencies and minimum hearing threshold) have been done on walrus. Because vocalizations associated with breeding behavior occur during the winter mating season, summertime seismic-survey activities are not expected to affect walrus breeding behavior. However, walrus might be impacted by vessel and aircraft traffic associated with seismic surveys. For example, walrus hunters and researchers have noted that walrus tend to react to the presence of humans and machines at greater distances from upwind approaches than from downwind approaches suggesting that odor may also be a stimulus for a flight response. The visual acuity of walrus is thought to be less than for other species of pinnipeds (Garlich-Miller, 2006, pers. commun.).

Based on previous monitoring efforts in the Chukchi Sea, exploration activities (seismic and, particularly, exploratory drilling) are expected to result in the take (Level B harassment) of up to several thousand walrus (Garlich-Miller, 2006, pers. commun.). The potential for direct impacts causing injury (Level A) from seismic surveys would be most likely if individuals entered the 190-dB zone immediately surrounding the high-energy sound source. Although the hearing sensitivity of walrus is poorly known, source levels are thought to be high enough to cause temporary hearing loss in other species of pinnipeds. Therefore, it is possible that walrus within the 190-decibel (dB re 1 μ Pa) safety radius sound cone of seismic activities (industry standard) could suffer temporary shifts in hearing threshold. With appropriate mitigation (e.g., marine mammal observers and shutdown procedures), it is unlikely that walrus would be exposed to sounds that could cause injury. Direct impacts potentially causing injury (Level A) from seismic surveys also could occur if walrus hauled out on icefloes stampede into the water due to the approach of seismic vessels or aircraft. Calves and young animals at the perimeter of these haulouts are particularly vulnerable to trampling injuries and to being separated from their mothers, which could prove fatal.

Seismic surveys should have no impacts on the availability of walrus prey due to the sedentary nature of their prey source (primarily bivalves).

Walrus do not typically frequent water depths >200 m, which may exclude them from some survey areas. Most seismic surveys will occur in areas of open water, where walrus densities are expected to be relatively low, and monitoring requirements and mitigation measures are expected to minimize interactions with large aggregations of walrus. Because seismic operations likely would not be concentrated in any one area for extended periods, any impacts to walrus should be relatively short in duration and should have a negligible overall impact on the Pacific walrus population.

Cetaceans. During 2D/3D seismic surveys, cetaceans could be adversely affected by noise and disturbance both from the seismic-sound sources; the seismic vessel; and from related support ships, boats, icebreakers, and aircraft. In addition, animals could be injured by very close proximity to airgun discharges, seismic ships or boats, aircraft, and small fuel spills. From a behavioral perspective, increased anthropogenic noise that would result from the Proposed Action could interfere with communication among cetaceans, mask important natural and conspecific sounds, or alter natural behaviors (i.e., displacement from migration routes or feeding areas, disruption of feeding or nursing). Behavioral impacts appear to be affected by the animal's sex and reproductive status, age, accumulated hearing damage, type of activity engaged in at the time, group size, and/or whether the animal has heard the sound previously (e.g., Olesiuk et al., 1995; Richardson et al., 1995a; Kraus et al., 1997; NRC, 2003, 2005). For example, cetacean females with calves show a heightened behavioral response to seismic noise (Henley and Ryback, 1995; McCauley et al., 2000). In other studies, animal reactions have been mixed during studies on the effects of seismic activity on feeding bowhead whales with some animals ceasing feeding and others continuing feeding (Fraker, Richardson, and Wursig, 1995; Richardson, Wells, and Wursig, 1985).

The seismic-survey PEA outlines the potential effects of noise and disturbance that can be expected from the Proposed Action on threatened and endangered marine mammals, with a particular focus on cetaceans. This information is incorporated by reference here as it directly applies to the discussion to follow on general impacts of seismic surveys on nonendangered and nonthreatened cetaceans (USDOI, MMS, 2006a:Secs. III.F.3.f(3), III.F.3.f(5), III.F.3.f(6), and III.F.3.f(8)). In addition, USDOI, MMS (2004) contains information on potential seismic-survey impacts to marine mammals in the Gulf of Mexico and is considered in the following analysis. The following information builds on the information contained within these two documents and provides a summary of potential impacts from seismic surveys on nonthreatened and nonendangered marine mammals found in the Proposed Action area. Conclusions are drawn based on this impact assessment and the potential for mitigation measures outlined in Section II.B.3 to lessen potential impacts to determine the overall level of anticipated impact from the Proposed Action.

The potential effects on prey species need to be considered in any evaluation of the effects of seismic surveys on cetaceans (IWC, 2006).

Odontocetes or Toothed Whales (Beluga Whale, Killer Whale, and Harbor Porpoise). Among the odontocetes, hearing thresholds are highly species-specific. The high range of hearing sensitivity falls within 80-150 kHz (Richardson et al., 1995a), with the greatest sensitivity to sounds above 10 kHz (USDOI, MMS, 2004). Killer whales are most sensitive at 20 kHz (Szymanski et al., 1999) with an upper frequency limit near 120 kHz (Bain, Kriete, and Dahlheim, 1993; Bain and Dahlheim, as cited in Au, 1993:33). Harbor porpoise hearing ranges from 1 kHz to over 100 kHz (Richardson et al., 1995a). Beluga whales appear to hear sounds from as low as 40-75 Hz, although their sensitivity at these low frequencies is considered poor, to over 100 kHz (Richardson et al., 1995a). The sensitivity of toothed whales to high-frequency sounds is attributed to their use of high-frequency sound pulses in echolocation and moderately high-frequency calls for communication.

Below the 10 kHz level, hearing ability deteriorates for toothed whales as frequency decreases, with the exception of the sperm whale (Carder and Ridgway, 1990). Below 1 kHz, hearing sensitivity of odontocetes is considered poor, although some species may be able to detect sound frequencies as low as 60-105 Hz (USDOI, MMS, 2004) and, in the case of beluga whales, as low as 40-75 Hz (Richardson et al., 1995a). Although most seismic-survey noise is concentrated below the 1 kHz level, more recent measurements of airguns at sea have shown that there is some level of significant seismic energy even within the higher frequency levels (Goold and Fish, 1998; Sodal, 1999). Therefore, although toothed

whales, such as the beluga and killer whale and the harbor porpoise, specialize in hearing ranges generally outside of the majority of seismic-survey impulse sounds, there still is the potential for sounds from these surveys to fall within the acoustic sensitivity of toothed whales.

There have been no documented instances of deaths, physical injuries, or auditory (i.e., temporary or permanent threshold shifts or other physiological) effects on toothed whales, or any marine mammal, from seismic-survey activity. Despite this, MMS recognizes that it may be difficult to document injury or harm, and that the potential for injury still may exist, particularly if individuals entered the 180-dB zone immediately surrounding the high-energy source or were struck by seismic vessels or support ships (USDOI, MMS, 2004). However, with appropriate protective measures in place as discussed in Section II.B.3 (e.g., marine mammal observers and shutdown procedures), individuals are not likely to be exposed to sound levels that could cause injury, and visual observance of the zone surrounding vessels would limit the potential for vessel strikes to occur.

Overall, little research has been done to study the effects of seismic activity, and related vessel and air traffic, on the behavior of toothed whales other than the sperm whale. However, a number of studies are useful in drawing conclusions on potential impacts. For example, Van Parijs and Corkeron (2001) found that vessel presence can affect the acoustic behavior of dolphins, particularly mother/calf pairs, by increasing the rate of vocalization (perhaps in an attempt to maintain group cohesion) as vessels passed through the area. Other studies have shown that seismic-survey pulses change the vocal behavior of common dolphins in the open sea (Wakefield, 2001) and that certain dolphin species are sighted less often in the vicinity of surveys when the guns were firing than when the guns were silent (Stone, 1997, 1998, 2000). Morton and Symonds (2002) found in a 15-year study of killer whales in Johnstone Strait and Broughton Archipelago that killer whale presence was significantly lower during a 7-year period when acoustic harassment devices (10 kHz devices with source levels of 194 dB re: 1 μ Pa at 1 m) were installed in the area, and the number of whales returned to baseline estimates when the sound source was removed. The control population of killer whales included in this study did not experience changes in individuals present over that same time period. Kraus et al., (1997) found acoustic alarms operating at 10 kHz with a source level of 132 dB re 1 μ Pa at 1 m were an effective deterrent for harbor porpoises and harbor seals. Again, the protective measures in place as discussed in Section II.B.3 would seek to limit any potential effects to Level B Harassment (disturbance) and even minimize the degree of Level B Harassment that might occur.

Beluga whales in the Alaskan Arctic consistently congregate in shallow coastal or estuarine waters during at least a portion of the summer. In the Eastern Chukchi, these areas of concentration are known to occur in Kotzebue Sound and Kasegaluk Lagoon. Research suggests these areas are likely used for molting, and some of the largest gravel beds occur there. Beluga whales also can be found in large aggregations during the remainder of the summer, when they are located further offshore and associated with deeper slope water. Additional analysis must then be considered on how seismic activity may affect these concentrations of whales, especially when they are engaged in important biological behaviors such as feeding or molting. Such analysis was done in MMS's recent programmatic environmental analysis for 2006 exploration seismic surveying (USDOI, MMS, 2006a) and has been summarized here in the EIS.

In reviewing these life-history patterns of beluga whales and assessing the potential for disturbance from seismic activity, without appropriate mitigation, the potential exists for seismic activities to displace whales from these areas. However, given that mitigation measures in Section II.B.3 (and any imposed under the MMPA authorization process) are meant to lessen potential impacts, seismic activity at these areas potentially would result in an adverse but not significant impacts to beluga whales.

It is uncertain about how seismic surveys might impact odontocete food resources (e.g., a variety of fish, squid, other marine mammals, and shellfish) in the immediate vicinity of the survey. As previously discussed in the USDOI, MMS (2006a:Sec. III.F.1), direct and adverse impacts affecting some prey species (i.e., some teleost fishes) may last for days to weeks (e.g., displacement from foraging, staging, or spawning-habitat areas) or longer (i.e., auditory and/or vestibular harm that lasts months or even years).

Mysticetes or Baleen Whales (Minke and Gray Whales). Mysticetes, with their larger body and ear size and basilar membrane thickness-to-width ratio, are low-frequency hearing specialists, with an auditory range starting at 10 Hz and possibly moving as high as 30 kHz (Ketten, 1998). The most sensitive range

appears to occur below 1 KHz. Given that seismic surveys produce sounds in the frequency range used by baleen whales, including minke and gray whales, potential impacts to these species are considered greater than would occur with toothed whales.

Given the greater potential for anthropogenic-noise impacts on baleen whales, more research has been done to focus on potential effects on baleen whales than with toothed whales (although data is still considered limited). As with toothed whales, there have been no documented instances of deaths, physical injuries, or auditory (temporary or permanent threshold shifts or other physiological) effects from seismic surveys (USDOI, MMS, 2004). Although no documented injuries have occurred, MMS considers there to still be a potential for injury to marine mammals from seismic activities. However, the mitigation measures outlined in Section II.B.3 are designed to avoid Level A Harassment (potential to injure) and maintain any takes of marine mammals at or below Level B Harassment (potential to disturb).

Baleen whales also are subject to behavioral disturbance from the presence of anthropogenic noise. Overall, studies of gray, bowhead, and humpback whales have shown that received levels of impulses in the 160-170 dB re 1 μ Pa rms range appear to cause avoidance behavior in a significant portion of the animals exposed. Dahlheim (1987) reported that in noisy environments, gray whales increase the timing and level of their vocalizations and use more frequency-modulated signals. Malme et al. (1986, 1988) studied the responses of feeding eastern gray whales to pulses from a single 100-in³ airgun off St. Lawrence Island in the northern Bering Sea. They estimated, based on small sample sizes, that 50% of feeding gray whales ceased feeding at an average received pressure level of 173 dB re 1 μ Pa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB. Malme et al. (1986) estimated that an average pressure level of 173 dB occurred at a range of 2.6-2.8 km (1.4-1.5 nmi) from an airgun array with a source level of 250 dB (0-pk) in the northern Bering Sea. These findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast. Malme and Miles (1985) concluded that, during migration, changes in swimming pattern occurred for received levels of about 160 dB re 1 μ Pa and higher, on an approximate rms basis. The 50% probability of avoidance was estimated to occur at a CPA (closest point of approach) distance of 2.5 km (1.3 nmi) from a 4,000-in³ array operating off central California. This would occur at an average received sound level of about 170 dB (rms). Some slight behavioral changes were noted at received sound levels of 140 to 160 dB (rms). However, these slight behavioral changes at levels below 160 dB may have been more relevant to the location of the sound source as the seismic array was placed in the middle of the gray whale migratory pathway. In Würsig et al. (1999), observations of gray whales near Sakhalin Island found no indication that western gray whales exposed to seismic noise were displaced from these feeding grounds in 1999 and 2001. However, there were indications of subtle behavioral effects and, in 2001, whales shifted their distribution away from a region where geophysical seismic surveys were being conducted (Johnson 2002; Weller et al. 2002b).

Currently, gray whales are believed to congregate along offshore shoals in the northern Bering and Chukchi seas for feeding during the summer months. Larger aggregations of feeding whales have been reported at these shoals. It is likely that shallow coastal and offshore-shoal areas provide habitat rich in gray whale prey, and their association and congregation in larger numbers with offshore shoals in the northern Chukchi Sea may indicate that these are important feeding areas for the expanding population (Moore and DeMaster, 1997). Because gray whales typically have shown documented disturbance reactions at levels at or above 160 dB, the effects of seismic surveys at these feeding sites also must be considered. Without appropriate mitigation, the potential exists for seismic activities to displace whales from these areas. However, given the proposed mitigation measures in Section II.B.3 (and any imposed under the MMPA authorization process), seismic activity at these feeding areas likely would result in an adverse but not significant impacts to gray whales.

No studies are available specific to the effects of seismic-survey noise on minke whales, but the potential for impacts would be considered within the range of other baleen whales. Also, no known long-term impacts have been documented on gray and minke whale behavior as a result of seismic activity. However, mitigation and monitoring measures outlined in Section II.B.3 are considered to: (1) prevent Level A Harassment (injury); (2) lessen the potential for takes by Level B Harassment (disturbance); and (3) by limiting the potential for short-term harassment, ultimately avoid the potential for long-term, population-level effects.

Other Effects from Seismic Surveys: In addition to the potential effects from sound associated with seismic surveys, the potential exists for oil/fuel spills to occur from vessels and aircraft associated with the seismic-surveying activities. This risk is considered slight, and any spills most likely would be of small volume and are not considered a major threat to marine mammals in the Proposed Action area. Impacts, if any, most likely would include temporary displacement until cleanup activities are completed and short-term effects on health from the ingestion of contaminated prey.

IV.C.1.h(3) Effects from Exploration and Development. Under the Proposed Action, industrial activities may include, but are not limited to, artificial-island construction, operation of drilling barges (onshore and offshore), pipeline construction, seismic surveys, and vessel and aircraft operations. The largest issue for evaluation of impacts is the effect of noise and potential oil spills produced from these activities on marine mammals.

Because the marine waters of the Chukchi Sea have seen only limited and sporadic industrial activity, it is likely that there have been no serious effects or accumulation of effects to date on pinnipeds or fissipeds (polar bears) from industrial development in the Proposed Action area.

The main areas of concern regarding the effects of industrial development on marine mammals are the potential for contamination and for disturbance caused by industrial noise in the air and water. As far as is known, marine mammals have not been affected by oil spilled as a result of North Slope industrial activities, although at least one polar bear fatality has resulted from ingestion of industrial chemicals (Amstrup, Myers, and Oehme, 1989). Although the effects are unknown, industrial development has caused the development of a substantial amount of arctic haze in the Prudhoe Bay region, which likely precipitates into the marine environment as it drifts over the Arctic Ocean. Unfortunately, it has not been possible to predict the type and magnitude of marine mammal responses to the variety of disturbances caused by oil and gas operations and industrial developments in the Arctic. More importantly, it has not been possible to evaluate the potential effects on populations.

Drilling for oil and gas generally occurs from natural and artificial islands, caissons, bottom-founded platforms, and ships and submersibles. With varying degrees, these operations produce low-frequency sounds with strong tonal components. Drilling occurs once a lease has been obtained for oil and gas development and production and may continue through the life of the lease.

Near the Northstar facility in the Beaufort Sea, underwater sound from vessels often were detectable as far as 30 km offshore, while sounds from construction, drilling, and production reached background values at 2-4 km. BPXA began to use hovercraft in 2003 to access Northstar, which have proven to generate considerably less underwater noise than similar-sized conventional vessels and, therefore, may be an attractive alternative when there is concern over underwater noise (Richardson and Williams, 2004).

Noise and Disturbance. The 'noisiest' period of offshore oil and gas operations occurs during exploration and site establishment (Richardson et al., 1995a). Conversely, production activities generally are quieter and require fewer support operations.

The main noise-producing activities would include: (1) air-traffic noise; (2) construction; (3) drilling; (4) seismic surveys; and (5) vessel noise. The potential effects from these activities must be considered in light of other existing noise levels within the Proposed Actions area (e.g., shipping noise, sounds of physical and biological environment) to determine if the Proposed Action and these additional noise impacts cumulatively could result in significant impacts to nonthreatened and nonendangered marine mammals. Details on source- and received-sound levels for many of these activities can be found in the MMS *Biological Evaluation of the Potential Effects of Oil and Gas Leasing and Exploration in the Alaska OCS Beaufort Sea and Chukchi Sea Planning Areas on Endangered Bowhead Whales (*Balaena mysticetus*), Fin Whales (*Balaenoptera physalus*), and Humpback Whales (*Megaptera novaeangliae*)* (USDOI, MMS, 2006b) and Richardson et al. (1995a) and are considered in the analysis below.

Icebreaking activities likely would elicit strong responses from cetaceans and walrus.

Phocids (Ringed, Spotted, Ribbon, and Bearded Seals). The effects of air traffic on pinnipeds in the action area are expected to be local and transient in nature. Some groups of pinnipeds may be disturbed

from their haulouts and enter the water, although their responses will be highly variable and brief in nature. Mitigation measures prohibiting aircraft overflights of hauled out walrus below 1,000 ft will lessen aircraft impacts to these pinnipeds.

Moulton et al. (2005) reported that during spring surveys, there was no evidence that construction, drilling, and production activities at BPXA's Northstar oil development affected local ringed seal distribution and abundance. Drilling and production sounds from Northstar likely were audible to ringed seals, at least intermittently, out to ~1.5 km in water and ~5km in air (Blackwell, Greene, and Richardson, 2004). These results suggest that any negative effects on seals from individual developments are likely to be minor and very localized. Likewise, Richardson and Williams (2004) concluded that there was little effect from the low-to-moderate level, low-frequency industrial sounds emanating from the Northstar facility on ringed seals during the open-water period, and that the overall effects of the construction and operation of the facility were minor, short term, and localized, with no consequences to the seal populations as a whole.

However, vibroseis surveys have been shown to have a negative affect on observed seal densities (Link, Olson, and Williams, 1999). These activities have the potential to impact bearded and ringed seals and polar bears.

Pacific Walrus. Due to the tendency of walruses to aggregate in large groups, they are particularly vulnerable to disturbance events. Potential impacts to female walruses and dependent calves are a major concern and merit special consideration. Oil and gas activities that occur during ice-minimum conditions in summer in the Chukchi Sea are likely to come into direct contact with adult females and subadult walruses (Jay et al., 1996). If disturbance causes walruses to abandon preferred feeding areas or interferes with calf-rearing, resting, or other activities, then the walrus population could be negatively affected. Walruses will flee haulout locations in response to disturbance from aircraft and ship traffic, although reactions are highly variable (Richardson et al., 1995a). Females with dependent young are considered the least tolerant of disturbances. Helicopters are more likely to elicit responses than fixed-wing aircraft, and walruses are particularly sensitive to changes in engine noise and are more likely to stampede when aircraft turn or bank overhead. Based on previous monitoring efforts in the Chukchi Sea, exploration activities (seismic and, particularly, exploratory drilling) are expected to result in the take (Level B harassment) of up to several thousand walruses (Garlich-Miller, 2006, pers. commun.). Researchers conducting aerial surveys for walrus in sea ice habitats have reported little reaction to aircraft above 1,000 ft (305 m). Brueggeman et al. (1991) reported that 81% of walruses encountered by vessels in the Chukchi Sea exhibited no reaction to ship activities within less than a kilometer, which suggests that walruses may be tolerant of ship activities and movements. However, ice-management operations are expected to have the greatest potential for disturbances to walruses. For example, Brueggeman et al. (1991) reported that walruses moved 20-25 km from active icebreaking operations, where noise levels were near ambient. Conversely, researchers onboard an icebreaker during ice-management operations observed little or no reaction of hauled out walrus groups beyond 0.5 mi (805 m) of the vessel (Garlich-Miller, 2006, pers. commun.). Potential effects of prolonged or repeated disturbance include displacement from preferred feeding areas, increased stress levels, increased energy expenditure, masking of communication, and the impairment of thermoregulation of neonates that are forced to spend too much time in the water (Garlich-Miller, 2006, pers. commun.).

Cetaceans. Richardson et al. (1995a) suggest that airborne sounds (and visual stimuli) from aircraft may be less relevant to toothed whales than baleen whales, but reactions are variable. For example, beluga responses in offshore waters near Alaska ranged from no overt response to abrupt diving and avoidance, and generally increased with decreasing flight altitude. Reactions to aircraft include diving, tail slapping, or swimming away from the aircraft track. Gray whale mother-calf pairs seem to be sensitive, while migrating gray whale responses are not as detectable. In other cases, both baleen and toothed whales showed no reaction to aircraft overflights. In summary, responsiveness depends on variables, such as the animal's activity at the time of the overflight or altitude level of aircraft, and most animals quickly resume normal activities after the aircraft has left the area. Richardson et al. (1995a) state that there is no indication that single or occasional overflights can cause long-term displacement of cetaceans.

Vessel traffic in the Alaskan Arctic generally occurs within 20 km of coast and usually is associated with fishing, hunting, cruise ships, icebreakers, Coast Guard activities, and supply ships and barges. No

extensive maritime industry exists for transporting goods. Traffic in the Chukchi Sea at present is limited primarily to late spring, summer, and early autumn.

For cetaceans, the main potential for effects from vessel traffic is through vessel strikes and acoustic disturbance. Regarding sound produced from vessels, it is generally expected to be less in shallow waters (i.e., background noise only by 10 km away from vessel) and greater in deeper waters (traffic noise up to 4,000 km away may contribute to background noise levels) (Richardson et al., 1995b). Aside from seismic-survey vessels, barging associated with activities such as onshore and limited offshore oil and gas activities, fuel and supply shipments, and other activities contributes to overall ambient noise levels in some regions of the Chukchi Sea. Whaling boats (usually aluminum skiffs with outboard motors) also contribute noise during the fall whaling periods in the Chukchi Sea. Fishing boats in coastal regions also contribute sound to the overall ambient noise. Sound produced by these smaller boats typically is at a higher frequency, around 300 Hz (Richardson et al., 1995b).

If noise causes disruption of important behaviors such as mating, nursing, or feeding, or if animals are scared away from important habitat over long periods of time, then these impacts could affect the long-term survival of the population (Erbe and Farmer, 2000). Noise also can interfere with animals' communication signals, environmental sounds that animals might use for orientation (e.g., surf), and the sounds of predators and prey (Erbe and Farmer, 2000).

For example, Erbe and Farmer (2000) demonstrated that icebreaker noise was audible to beluga whales in the Beaufort Sea over very long ranges (35-78 km) and could interfere with beluga communication at ranges of 11-54 km. Changes have been observed in beluga swimming behavior at distances of 40-60 km from an icebreaker (Cosens and Dueck, 1988; Finley et al., 1990), and some researchers have concluded that belugas in the Arctic avoid icebreakers as soon as they detect them (Cosens and Dueck, 1988). Habituation or sensitization, however, likely affects the extent of this zone of disturbance. For example, beluga whales in the St. Lawrence Estuary approach large ships to much shorter distances (Sergeant and Hoek, 1987). Similarly, gray whales have been migrating past oil-exploration and -production activities in the Santa Barbara Channel off California for decades, suggesting that they habituate to, or at least tolerate, noise associated with exploration and production activities (Richardson et al., 1995a). One possible explanation is that these animals are more used to industrial noise and heavy traffic and, thus, are habituated to it. Conversely, they might be hearing impaired due to ongoing noise exposure (Erbe and Farmer, 2000) and, thus, desensitized.

Belugas generally do not get close enough to icebreakers for potentially harmful effects to occur. However, if the animals are engaged in important behavior such as mating, nursing, or feeding, they might not flee and might tolerate louder noises. Problems can arise in heavily industrialized areas where a variety of noisy activities take place such as seismic exploration, oil drilling, offshore construction, and ship and air traffic. Cumulative noise levels could be very high for long periods of time and cover such large areas that animals might be either permanently displaced or adversely affected, because they have nowhere to flee to (Erbe and Farmer, 2000).

The need to rely on indirect methods of assessing the environmental impact of human activity on marine mammals is a recurring problem (Inglis and Gust, 2003). Impact assessments for cetaceans typically emphasize immediate behavioral responses to human activities (Samuels and Bejder, 2004), the biological relevance of which is rarely known (Corkeron, 2004). Studies evaluating the effects of human activity on wildlife typically emphasize short-term behavioral responses, from which it is difficult to infer biological significance or to formulate plans to mitigate harmful impacts (Bejder et al., 2006). Furthermore, monitoring plans typically emphasize readily obtainable, short-term behavioral measures that can be directly related to disturbance factors (Bejder et al., 2006). However, it is rarely known in what ways short-term responses translate to longer term changes in reproduction, survival, or population size (Gill, Norris, and Sutherland, 2001; Beale and Monaghan, 2004a), and it is seldom possible to infer biological significance based on short-term behavioral observations.

Because cetaceans are long-lived and elusive animals, it is very challenging to assess the potential long-term effects of anthropogenic activities on them (Williams, Lusseau, and Hammond, 2006). Clearly, linking short-term behavioral responses to long-term population-level impacts presents difficulties, a fact that can lead to the false, or at least premature, conclusion that human activities have no biologically

significant effects on the species in question (Williams, Lusseau, and Hammond, 2006). There are indications that repeated short-term avoidance tactics can lead to long-term impacts at the population level, either through displacement from important habitats (Morton and Symonds, 2002; Lusseau, 2005; Bejder et al., 2006), which can reduce the fitness of targeted populations, or via physiological constraints at the individual level, which may lead to decreased reproductive output (Lusseau, 2003). For a food-limited population, energetics may provide the causal link between demonstrable short-term behavioral responses and difficult-to-detect population level impacts (Williams, Lusseau, and Hammond, 2006). Therefore, the relationship between an animal's response to disturbance and its underlying sensitivity is not straightforward (Gill, Norris, and Sutherland, 2001; Beale and Monaghan, 2004a,b). Equating lack of response with indifference may be incorrect; those animals least likely to exhibit avoidance responses simply may be those that can least afford to demonstrate their sensitivity, namely those in poorest body condition (Beale and Monaghan, 2004b). Conversely, animals that show little response to disturbance simply may be habituated to it.

Whales have been shown to alter their behavior around various vessels, including whale-watching and fishing boats (Williams, Trites, and Bain, 2002). For example, in the presence of whale-watching and fishing boats in Johnstone Strait, British Columbia, killer whales increased their travel budgets by 12.5% and reduced the time they spent feeding. These lost feeding opportunities could have resulted in a substantial (18%) estimated decrease in energy intake (Williams, Lusseau, and Hammond, 2006). These observations suggest that to lessen the potential impacts of human activities, avoiding impacts to important feeding areas would provide considerable benefits to cetaceans and other marine mammals that are sensitive to human disturbance.

Marine mammals temporarily may move away from areas of heavy vessel activity but reinhabit the same area when traffic is reduced (Allen and Read, 2000; Lusseau, 2004), or they may abandon a once-preferred region for as long as disturbance persists (Gerrodette and Gilmartin, 1990). For example, evidence exists that indicates that killer whales evade potentially harmful noise on annual and regional spatial scales (Morton and Symonds, 2002). When animals switch from short-term evasive tactics to long-term site avoidance in response to increasing disturbance, the costs of tolerance likely have exceeded the benefits of remaining in previously preferred habitat. For example, in a long-term study in Shark Bay, Western Australia, cumulative vessel activity was shown to result in a decline in abundance of bottlenose dolphins over a relatively short time (Bejder et al., 2006). The authors attributed this to the long-term displacement of dolphins away from the area of disturbance. For animals such as cetaceans that exhibit enduring, individually specific social relationships, disruption of social bonds through displacement of sensitive individuals may have far-reaching repercussions (Bejder et al., 2006). Given the scarcity of long-term studies to fully evaluate the potential impacts of human activities, a cumulative impact, like those detected in Shark Bay and Johnstone Strait, could go unnoticed for decades. Thus, management deliberations must draw strong inferences from well-documented sites, where long-term information can be taken into account (Bejder et al., 2006).

Noise, rather than the simple presence of boats, seems the likeliest mechanism for boats to alter whale behavior. It is perhaps unsurprising that cetaceans have been shown to shorten their feeding bouts and initiate fewer of them in the presence of ships and boats (Williams, Lusseau, and Hammond, 2006). Such behavior has been shown throughout the animal kingdom in response to human disturbance. For example, many bird species have been observed to shorten their feeding bouts in response to human presence (Burger, Niles, and Clark, 1997; Galicia and Baldassarre, 1997; Ronconi and St. Clair, 2002). Terrestrial animals also have been shown to reduce food intake as a consequence of human disturbance. For example, grizzly bears (*Ursus arctos*) in Glacier National Park spent 53% less time feeding when disturbed by climbers (White, Kendall, and Picton, 1999). Similarly, Amur tigers (*Panthera tigris altaica*) in Russia showed strong vulnerability to human disturbance along road corridors (Kerley et al., 2002). Tigers at undisturbed sites spent more time at kills and consumed more of their kills than tigers in areas disturbed by humans. For tigers that occupied roaded areas, human disturbance was linked also to lower reproductive success and higher adult mortality (Kerley et al., 2002). For marine mammals, it is reasonable to assume that larger and noisier vessels, such as seismic and icebreaking ships, would have greater and more dramatic impacts on behavior than would smaller vessels.

The real issue may not be the increased expenditure of energy by cetaceans to avoid ships, but rather the potential for ships and seismic vessels to cause a reduction in their overall energy acquisition, via the

masking effects of noise, interruption of feeding activities, or replacement of feeding activity with ship-avoidance activities (Williams, Lusseau, and Hammond, 2006). Disruption of feeding activity could lead to a substantial decrease in energy intake for animals exposed to ship disturbance. In fact, the energetic consequences of reduced energy acquisition have the potential to be at least four to six times as great as the cost of avoidance behavior (Williams, Lusseau, and Hammond, 2006). In food-limited populations, this is one mechanism that could link short-term consequences of vessel traffic to long-term, population-level consequences (Williams, Lusseau, and Hammond, 2006). For example, increasing whales' energetic costs or reducing their ability to acquire prey, if the effect is sufficiently strong, can change the demographic parameters that influence effective population size (Anthony and Blumstein, 2000). Therefore, marine "protected areas" could play a role in reducing the "take" of cetaceans, as long as these areas are located where whales concentrate their feeding activities. Such areas would greatly help to mitigate potential impacts to cetaceans from human activities.

IV.C.1.h(4) Effects from Oil Spills. Freshly spilled oil contains high levels of toxic aromatic compounds that, if inhaled, can cause serious health effects or death. Oil that moves some distance from a site still may or may not (e.g., depending on temperature and whether the oil becomes frozen into ice) have high levels of toxic aromatic compounds.

Should development and production occur in the Chukchi Sea OCS, the estimated chance of one or more spills $\geq 1,000$ bbl occurring in the Chukchi Sea OCS is estimated to be about 40%.

Specific areas of concern for walrus, polar bears, and belugas include the following land segments (LS's) and ERA's:

- **Beluga Whales:** Kasegaluk Lagoon ERA 1
- **Polar Bears:** Wrangel Island ERA 11, Kolyuchin Island ERA 59, Russian Chukchi coast LS 95, and Barrow area LS 85
- **Walrus:** Cape Lisburne LS 65, Russian Chukchi coast LS 95, Cape Blossom LS 1, Somnitel'naya Spit LS 11, Kardkarpko Island LS 28, Onmyn Cape LS 29, Kolyuchin Island ERA 59, Ildidlya Island LS 33, 34, Cape Serdtse-Kamen LS 35, 36, Cape Unikyn LS 38, and Cape Peek- LS 39

Phocids (Ringed, Spotted, Ribbon, and Bearded Seals). Corneal ulcers and abrasions, conjunctivitis, and swollen nictitating membranes were observed in captive ringed seals placed in crude oil-covered water (Geraci and Smith, 1976), and in seals in the Antarctic after an oil spill (Lillie, 1954). After seals were experimentally dosed with crude oil, increased gastrointestinal motility and vocalization and decreased sleep were observed (Geraci and Smith, 1976; Engelhardt, 1985, 1987). One study found that, after the EVOS, there was no evidence that seals were displaced from oiled sites by the spill and associated activities (Frost et al., 2004). However, aerial counts indicated that 26% less pups were produced at oiled sites in 1989 than would have been expected without the oil spill (Frost et al., 2004). This demonstrates the importance of evaluating the effects of anthropogenic perturbations, such as oil spills, in the context of historical data. Without historical data on distribution and abundance, it is not possible to measure the impacts of an oil spill on marine mammals. Population-monitoring studies for key species need to be implemented in areas where significant industrial activities are likely to occur, so that it will be possible to compare future impacts with historical patterns and thus determine the magnitude of any potential effects (Frost et al., 2004).

Walruses. Due to the tendency of walruses to aggregate in large groups, their longevity, and their low rates of reproduction, walruses are particularly vulnerable to population-level perturbations and would require more time to recover from population-level impacts than would species with different life history strategies. Furthermore, potential impacts to female walruses and dependent calves are a major concern and merit special consideration.

Walruses are most vulnerable to the effects of an oil spill at coastal haulouts, particularly along the northern coast of Chukotka and Wrangel Island, where the preponderance of walruses using haulouts in the autumn are females and juveniles (Kochnev, 2004). There are nine major walrus haulouts along the coast of the Russian Chukchi Sea: Cape Blossom and Somnitel'naya Spit on Wrangel Island, and Kardkarpko Island, Onmyn Cape, Kolyuchin Island, Ildidlya Island, Cape Serdtse-Kamen, Cape Unikyn, and Cape Peek on the

north coast of Chukotka (Kochnev, 2004). Up to 125,000 walrus, mostly females with calves, have been estimated to use coastal haulouts on Wrangel Island in the Russian Arctic (Kochnev, 2004). Displacement from these crucial areas likely would result in population-level impacts on recruitment and survival. Walrus are long-lived animals with low rates of natural mortality and low rates of reproduction. This life-history strategy will severely limit the ability of the Pacific walrus population to recover from any adverse impacts associated with a large oil spill. Therefore, an oil spill impacting these areas could have a significant impact on the Pacific walrus population. On the American side of the Chukchi, walrus-haulout sites are relatively rare (Kochnev, In prep.), although in recent years, Cape Lisburne has seen regular walrus use in the late summer (Garlich-Miller, 2006, pers. commun.). Other traditional haulout sites in the eastern Chukchi Sea include Cape Thompson and Icy Cape.

Based on the OSRA model, if a large oil spill does occur from any launch area or pipeline, the chance of it contacting the Russian Chukchi coast, including Wrangel and Kolyuchin islands (LS 95), during summer ranges from <0.5-13% over a period of 10-60 days (Appendix A, Tables A.2-38, 39, and 40). For Cape Lisburne (LS 65), these values range from <0.5-7%. If a large spill did contact the shoreline, spilled oil could persist in sediments for more than a decade (USDOJ, MMS, 2003a:Sec. IV.C.2.a(3)(b)(2)).

Spilled oil can have dramatic and lethal effects on marine mammals, as has been shown in numerous studies, and a large oil spill could have major effects on walrus (St. Aubin, 1990a). The persistence of toxic subsurface oil and chronic exposures, even at sublethal levels, can have long-term effects on wildlife (Peterson et al., 2003). For example, as a result of the EVOS, oil persisted in surprising amounts and in toxic forms in coastal areas of southcentral Alaska and was sufficiently bioavailable to induce chronic biological exposures in animals for more than a decade, resulting in long-term impacts at the population level, particularly for species closely associated with shallow sediments (Peterson et al., 2003). Although it may be true that small numbers of walrus may be affected by an oil spill initially, the long-term impact potentially could be much worse. Oil effects can be substantial over the long term through interactions between natural environmental stressors and compromised health of exposed animals, and through chronic, toxic exposure as a result of bioaccumulation (Peterson et al., 2003). Because walrus can be considered a top predator of the arctic ecosystem, they are biological sinks for lipophilic pollutants that biomagnify up the food chain (Norstrom et al., 1988). Consequently, walrus would be very susceptible to the effects of bioaccumulation of contaminants associated with spilled oil, which would affect their reproduction, survival, and immune systems (USDOJ, MMS, 2004:Sec. IV.E.2.e(1)(c)). Sublethal, chronic effects of any oil spill can be expected to suppress the recovery of walrus populations due to reduced fitness of surviving animals. Sublethal doses of oil contaminants can cause delayed population impacts such as compromised health, growth, reproduction, and reduced survival in generations born after the spill (Peterson et al., 2003). Additionally, reductions in walrus prey resulting from an oil spill could result in reduced walrus recruitment and survival.

Determining oil-spill effects on walrus prey species is difficult. Clam-patch size and density are highly variable, and such information for high-latitude mollusks is sparse and highly variable (Ray et al., 2006). However, walrus feeding may deplete areas of prey quickly and alter community composition (Ray et al., 2006). The large mollusks that walrus feed on are mostly slow-growing species and, thus, vulnerable to overexploitation or other disruptions (e.g., oil spills) to their populations (Ray et al., 2006). Recovery from any disruption would be slow in the cold, seasonally ice-covered Chukchi Sea (Oliver et al., 1983). For example, populations of amphipods (another benthic invertebrate) off the coast of France were reduced by 99.3% following the *Amoco Cadiz* oil spill in 1978 (~70 million gallons). Ten years after the spill, amphipod populations had recovered to only 39% of their original maximum densities (Dauvin, 1989, as cited in Highsmith and Coyle, 1992). Because walrus are long-lived animals at the top of the food chain and, thus, subject to the upward biomagnification of contaminants, the effects from contaminants on the Pacific walrus population from a large oil spill are likely to persist for decades.

Cetaceans. This section draws heavily from the *Biological Evaluation of the Potential Effects of Oil and Gas Leasing and Exploration in the Alaska OCS Beaufort Sea and Chukchi Sea Planning Areas on Endangered Bowhead Whales (*Balaena mysticetus*), Fin Whales (*Balaenoptera physalus*), and Humpback Whales (*Megaptera novaeangliae*)*, published in March 2006 by MMS (USDOJ, MMS, 2006b). The following information builds on the information contained in that document.

Cetaceans that inhabit areas that are in the path of a major oil spill can be impacted in several different ways. First, individuals potentially could be directly affected by contact with the oil or its toxic constituents through inhalation of aromatic fractions of unweathered oil (probably the most serious threat to cetaceans), ingestion (of the oil itself or of contaminated prey), fouling of baleen, and surface contact. Second, they could be indirectly impacted if the quality or quantity of their prey were reduced. Third, individuals could be directly or indirectly affected due to maternal effects (for example, changes in food assimilation during pregnancy, or reduced maternal health) or in-utero exposure to toxic components of oil. Fourth, they could be affected by disturbance of spill-response and -cleanup activities.

The potential for a population-level effect may exist if large numbers of females and calves, especially newborn or very young calves, were contacted by large amounts of freshly spilled oil. However, if mortality of cetaceans occurred after exposure to a large oil spill, it would not be consistent with most published findings of impacts of oil spills on cetaceans. Information about environmental impacts on whales is rudimentary and full of speculation and uncertainty. Thus, impacts such as the sublethal impacts observed on sea otters (for example, reduced body condition, abnormal health, etc.) (see Rotterman and Monnett, 2002, and references cited therein) after the EVOS are unlikely to be documented in cetaceans, because the data needed to determine whether or not such impacts exist cannot be collected. Unless baseline data are exceptionally good, determination of an effect is only possible if the effect is dramatic. Thus, the potential for long-term sublethal (for example, reduced body condition, poorer health, or longer dependency periods), or lethal effects from large oil spill on cetaceans is unknown. However, observations of cetaceans behaving in a lethargic fashion or having labored breathing has been documented in more than one species, including in gray whales after the EVOS, in which large numbers of individuals were subsequently found dead.

Matkin et al. (1994) reported that killer whales had the potential to contact or consume oil, because they did not avoid oil or avoid surfacing in slicks. In the 2 years following the EVOS, significant numbers (13) of individual whales, primarily reproductive females and juveniles, disappeared from the AB pod. This mortality was significantly higher than in any other period except when killer whales were being shot by fishers during sablefish fishery interactions (Matkin et al., 1994). Harvey and Dahlheim (1994) observed 18 killer whales, including 3 calves, and saw the pod surface in a patch of oil. Dahlheim and Matkin (1994) also reported seeing AB pod members swim through heavy slicks of oil. Dahlheim and Matkin (1994:170) concluded that there is a spatial and temporal correlation between the loss of the whales and the EVOS, but there is no clear cause-and-effect relationship.

Migrating gray whales show only partial avoidance to natural oil seeps off the California coast. After the EVOS, gray whales were seen swimming through surface oil along the Alaskan coast. Laboratory tests suggest that gray whale baleen, and possibly skin, may be resistant to damage by oil. However, spilled oil, and the chemical dispersants used to break up surface oil and cause it to sink, could negatively affect gray whales by contaminating benthic prey, particularly in a primary feeding areas (Wursig, 1990; Moore and Clarke, 2002). Any perturbation, such as an oil spill, which caused extensive mortality within a high-latitude amphipod population with low fecundity and long generation times would result in a marked decrease in secondary production (Highsmith and Coyle, 1992). For example, populations of amphipods off the coast of France were reduced by 99.3% following the *Amoco Cadiz* oil spill in 1978 (~70 million gallons). Ten years after the spill, amphipod populations had recovered to only 39% of their original maximum densities (Dauvin, 1989, as cited in Highsmith and Coyle, 1992). Bering/Chukchi Sea amphipod populations, with their longer generation times and lower growth rates, probably would take considerably longer to recover from any major population disruption (Highsmith and Coyle, 1992).

Neither mysticete nor odontocete whales seem to consistently avoid oil, although they can detect it (Geraci, 1990). However, in captivity, bottlenose dolphins avoided an oiled area (Geraci, St. Aubin, and Reisman, 1983). Geraci (1990) reported that fin whales, humpbacks, dolphins and other cetaceans have been observed entering oiled areas and behaving normally. After the EVOS, Dall's porpoises were observed 21 times in light sheen, and 7 times in areas with moderate to heavy surface oil (Harvey and Dahlheim, 1994). Geraci (1990) summarized available information about the physiological and toxic impacts of oil on cetaceans (Geraci, 1990:Table 6-1). He concluded that although there have been numerous observations of cetaceans in oil after oil spills, there were no certain deleterious impacts.

IV.C.1.h(4)(a) Effects of Inhalation of Toxic Components of Crude Oil. The greatest threat to large cetaceans probably is from inhalation of volatile compounds present in fresh crude oil. Based on literature on other mammals indicating severe adverse effects from inhaling the toxic aromatic components of fresh oil, mortality of cetaceans could occur if they surfaced in large quantities of fresh oil. Inhalation of volatile hydrocarbon fractions of fresh crude oil can damage the respiratory system (Hansen, 1985; Neff, 1990), cause neurological disorders or liver damage (Geraci and St. Aubin, 1982), have anesthetic effects (Neff, 1990) and, if accompanied by excessive adrenalin release, can cause sudden death (Geraci, 1988). This is most likely if calves were exposed to fumes from a large spill. Calves take more breaths than do their mothers and spend more time at the surface. Thus, they potentially would be most likely to succumb to inhalation of toxic aromatic compounds.

Geraci and St. Aubin (1982) calculated the concentrations of the more volatile fractions of crude oil in air associated with a theoretical spill of a typical light crude oil. Their results showed that vapor concentrations could reach critical levels for the first few hours after a spill. Animals that are away from the immediate area or that are exposed to weathered oils would not be expected to suffer serious consequences from inhalation, regardless of their condition. The most serious situation would occur if oil spilled into a lead from which whales could not escape. In this case, Bratton et al. (1993) theorized that whales could inhale oil vapor that would irritate their mucous membranes or respiratory tract. They also could absorb volatile hydrocarbons into the bloodstream. Within hours after the spill, toxic vapors from oil in a lead could harm the whales' lungs and even kill them. The number of whales affected would depend on how large the spill was, its behavior after being spilled, and how many whales were present in areas contacted in the first days following the spill.

Based on evidence of observation of individuals from the AB pod of killer whales in heavy oil, and large disappearances of whales from the AB pod in the 2 years following that exposure (Dahlheim and Matkin, 1994; Harvey and Dahlheim, 1994), one could conclude that whales are vulnerable if they are present within a large spill, probably due to inhalation. However, this link is circumstantial, and there is not agreement in the scientific community as to whether or not there likely was an oil-spill impact on killer whales after the EVOS. Similarly, gray whales exhibiting abnormal behavior were observed in oil after the EVOS in an area where fumes from the spill apparently were very strong (J. Lentfer, cited in Harvey and Dahlheim, 1994). Subsequently, large numbers of gray whale carcasses were discovered. One of three of these whales had elevated levels of polycyclic aromatic hydrocarbons (PAH's) in its blubber. Loughlin (1994) concluded it was unclear what caused the death of the gray whales. During the oil spill off Santa Barbara in 1969, an estimated 80,000 bbl 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. Subsequently, 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 Battelle Memorial Institute concluded the whales were either able to avoid the oil, or were unaffected when in contact with it.

The potential effect of crude oil on the function of the cetacean blowhole is unknown. As noted, a Dall's porpoise was observed after the EVOS with crude oil covering its skin and blowhole. This individual was described as having labored breathing. Other porpoises swimming in the same area in oil did not appear to be oiled or to show abnormal behavior (Harvey and Dahlheim, 1994).

Based on all available information, if individual, small groups or, less likely, large groups of whales were exposed to large amounts of fresh oil, especially through inhalation of highly toxic aromatic fractions, they might be seriously injured or die from such exposure. Although there is very little definitive evidence linking cetacean death or serious injury to oil exposure, disappearances (and probable deaths) of killer whales and the deaths of large numbers of gray whales both coincided with the EVOS and with observations of members of both species in oil. However, in these two cases, even if one assumed that both the disappearances of the killer whales and the high number of gray whale carcasses were the result of the coinciding oil spill, it is unlikely that there would be a significant population-level adverse effect in the event of a large oil spill.

The potential for there to be long-term sublethal (for example, reduced body condition, poorer health, reduced immune function, reduced reproduction or longer dependency periods) effects on large cetaceans from a large oil spill essentially is unknown. There are no data on large cetaceans adequate to evaluate the probability of sublethal effects.

The effects of oil contacting skin largely are speculative. 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 EVOS. 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. However, as noted above in the review of observations following other spills, observations of cetaceans behaving in a lethargic fashion or having labored breathing have been documented in more than one species, including one in which large numbers of individuals were subsequently found dead.

Histological data and ultrastructural studies by Geraci and St. Aubin (1990) showed that exposures of skin to crude oil for up to 45 minutes in four species of toothed whales had no effect. They switched to gasoline and applied the sponge up to 75 minutes. This produced transient damage to epidermal cells in whales. Subtle changes were evident only at the cell level. In each case, the skin damage healed within a week. The authors concluded that a cetacean's skin is an effective barrier to the noxious substances in petroleum. 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.

Although oil is unlikely to adhere to smooth skin, it may stick to rough areas on the surface (Henk and Mullan, 1997). Haldiman et al. (1985) found the epidermal layer to be as much as seven to eight times thicker than that found on most whales. They also 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) suggested 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). He theorized 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 whales. Albert (1981) noted that eroded skin may provide a point of entry into the bloodstream for pathogenic bacteria, if the skin becomes more damaged. Evidence from Shotts et al. (1990) 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. Thus, whales likely would be most vulnerable to an oil spill while molting.

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. Therefore, based on the discussion above, it is reasonable to assume that beluga whales are more vulnerable to oil-spill effects when they are molting. Large numbers of belugas gather in Kasegaluk Lagoon every summer to molt. According to OSRA modeling, the chance of an oil spill contacting this area (ERA 1) if a large oil spill occurs for any launch area or pipeline during the summer ranges from <0.5-34% over a period of 3-60 days (Appendix A, Tables A.2-25, 26, 27, and 28). If a large spill did contact the shoreline, spilled oil could persist in sediments for more than a decade (USDOJ, MMS, 2003a:Sec. IV.C.2.a(3)(b)(2)).

Beluga whales also would be vulnerable to oil contact during the spring migration throughout the spring lead system. Contamination of the ice-lead system from an oil slick during spring migration (April-June) could expose whales directly to some oil-spill contact.

A large oil spill could have significant impacts to beluga prey species, including anadromous and coastal spawning species such as salmon (Sec. IV.C.1.d). If a significant impact to anadromous and coastal spawning species occurred, the effects on belugas would be detrimental, but the magnitude unknown.

IV.C.1.h(4)(b) Conclusions of Potential Oil-Spill Effects.

The effects of a large oil spill and subsequent exposure of whales to fresh crude oil are uncertain, speculative, and controversial. The effects would depend on how many whales contacted oil; the ages and reproductive condition of the whales contacted; the duration of contact, the amount of oil spilled, and the age/degree of weathering of the spilled oil at the time of contact. 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 whales, a large portion of the population could be exposed to spilled oil. If a very large slick of fresh oil contacted a large aggregation or aggregations of feeding whales, especially with a high percentage of calves, the effect might be expected to be greater than under more typical circumstances.

There is great uncertainty about the effects of fresh crude oil on cetacean calves. Prolonged exposure to freshly spilled oil could kill some adult whales but, based on available information, the number likely would be small if the spill contacted them in open water. However, Engelhardt (1987) theorized that some 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. There is some uncertainty and disagreement within the scientific community on the results of studies on the impacts of the EVOS on large cetaceans (for example, Loughlin, 1994; Dahlheim and Matkin, 1994; Dahlheim and Loughlin, 1990). If baleen is fouled and if crude oil is ingested, there could be adverse effects on the feeding efficiency and food assimilation of gray whales. Such effects are expected to have the most impact to calves, pregnant females, and lactating females. Ingestion, surface contact with, and especially inhalation of fresh crude oil has been shown to cause serious damage and even death in many species of mammals. This does not mean that such effects would occur. Such an assumption, if it provides an overestimate of potential effects, is more protective of the population than erring on the side of assuming that such impacts could not occur because they previously have not been documented.

Larger groups could be adversely affected if a large spill occurred when large aggregations of whales were feeding or molting.

There are no data available on which to evaluate the potential effect of a large or very large spill on baleen whale calves, on females who are very near term or who have just given birth, or on females accompanied by calves of any age. However, it is not unlikely that newborn and other young calves would be more vulnerable to the acute and chronic effects of oil than would adult whales. Calves swim slower, take more breaths, are on the surface more often, and have higher metabolisms than do adults. They could be exposed to oil on their mother's skin during nursing. They could receive pollutants through their mothers' milk, as well as through direct ingestion.

It is likely that some whales would experience temporary or perhaps permanent nonlethal effects, including one or more of the following symptoms:

- inhaling hydrocarbon vapors;
- ingesting oil and oil-contaminated prey;
- fouling of their baleen and reduced foraging efficiency;
- oiling their skin, causing irritation;
- losing some proportion of their food source; and
- 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, but the number likely would be small.

In conclusion, there is uncertainty about effects on cetaceans in the event of a large spill. There are, in some years and in some locations, relatively large aggregations of feeding and molting whales within the proposed lease-sale area. If a large amount of fresh oil contacted a significant portion of such an aggregation, effects potentially could be greater than typically would be assumed; and we cannot rule out population-level effects, if a large number of females and newborn or very young calves were contacted by a large amount of fresh crude oil. Available information indicates it is unlikely that whales would be likely to suffer significant population-level adverse effects from a large spill originating in the Chukchi Sea. However, individuals or small groups could be injured or potentially even killed in a large spill, and oil-spill-response activities (including active attempts to move whales away from oiled areas) could cause short-term changes in local distribution and abundance.

IV.C.1.h(5) Effectiveness of Mitigation Measures.

The standard mitigation available includes a measure for Orientation Programs. It requires all personnel involved in petroleum activities on the North Slope as a result of the proposed lease sale to be aware of the unique environment and social and cultural values of the area, which would include marine mammals.

Mitigation also is provided by several ITL's, such as Information on Bird and Marine Mammal Protection and Information on Discharge of Produced Waters. The ITL on Marine Mammal Protection advises lessees that during the conduct of all activities the lessee will be subject to the MMPA. Further, this ITL encourages lessees to "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." Disturbance of marine mammals could be determined to constitute a "taking" under the Act. The ITL on produced waters advises lessees that the State of Alaska prohibits discharges of produced water on State tracts within the 10-m depth contour.

Another measure—Stipulation No. 4 Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources—would give direct benefits. The stipulation provides site-specific information about the (disturbance) of bowhead whales that could occur from oil and gas activities from the proposed lease sales. Sightings of beluga whales also are documented. The information can be used to evaluate the threat of harm to the species and provides immediate information about the activities of whales and their responses to specific events.

For 2D/3D seismic operations related to the Proposed Action, MMS permits would require that vessels actively conducting seismic surveying maintain a minimum 15-mi distance from other seismic vessels. This is partly to avoid any cumulative effects from numerous vessels on the environment, but also to ensure data collection is not affected by the presence of other seismic-survey acoustic sources.

The potential for significant impacts to cetaceans from seismic surveying is limited through: (1) the required 15-mi separation for MMS-permitted surveys; (2) the mitigation and monitoring measures imposed for MMS permits (see Section IV); (3) requirements imposed under MMPA authorizations obtained by the seismic operators for mitigation to reduce impacts to species and subsistence; and (4) the expectation that these surveys would not coincide temporally or spatially. However, the potential for impacts to nonthreatened and nonendangered cetaceans exists from these survey activities.

A recent report from the IWC Scientific Committee recommended that mitigation measures should be practical (i.e., data should be readily collectable by marine mammal observers during offshore surveys), account for operating conditions and constraints of seismic surveys, and minimize disruption of surveys as much as possible while maximizing environmental protection. The Committee also recommended that procedures and protocols should be based on a conservative approach due to the levels of uncertainty with regard to impacts upon marine mammals (IWC, 2006). This is particularly relevant for the Chukchi, where there is a paucity of recent data upon which to base informed decisions upon.

In light of the uncertainty over the potential impacts of exploration and development activities, the earliest possible establishment of long-term monitoring programs for vulnerable species in the project area should

be pursued. The design of long-term monitoring should take into account the likely size of any effect and the probability of detecting it within a reasonable time span (IWC, 2006).

The group strongly recommended the value of well-planned and properly conducted long-term monitoring studies with properly conceived control populations to measure effects at the population level. The group recommended that this problem should be approached from the perspectives of both proximate behavioral response and population trend. It further recommended that, whenever possible, population parameters be measured directly as part of long-term monitoring studies. Additionally, behavior pertinent to biologically relevant activities and vital rates should be quantified and used in models that integrate behavioral responses as a factor in population-level observations (IWC, 2006).

The group also recommended that the collection of data from seismic surveys on the number of crews and areas of operation should be standardized, transparent, and ideally mandatory throughout the industry. The minimum data stored would be a summary of the temporal and spatial coverage of each survey, the number of vessels involved and the size of the airgun array, and any mitigation measures that were applied. Highly desirable would be data on the time and location of start and end points for each line and for any test firing (IWC, 2006).

Understanding the distribution and timing of movements of belugas is important for planning lease sales in the Chukchi Sea and designing possible mitigation measures. Late-summer distribution and fall-migration patterns are poorly known, wintering areas effectively are unknown, and areas that are particularly important for feeding have not been identified (Suydam, Lowry, and Frost, 2005).

IV.C.1.h(6) Marine Fissipeds - Polar Bear. Given the proposed listing of polar bears as a threatened species under the Endangered Species Act, MMS will work in close coordination with the FWS as listing occurs to further review and identify the specific oil and gas activities that are likely to affect polar bears and identify mitigation and monitoring measures that seek to reduce the potential for impacts to occur. Impacts to polar bears are an increasing concern due to ongoing changes in their sea-ice habitat, their distribution, and the uncertain status of their populations (Sec. III.B.6). For purposes of this analysis, a significant impact to polar bears is defined as: “An adverse impact that results in an abundance decline and/or change in distribution requiring...one or more generations...for the indicated population to recover to its former status.

Documented impacts to polar bears to date in Alaska by the oil and gas industry appear minimal. However, increased bear-human interactions and Level B harassment of polar bears are likely to increase with increasing industrial activity in the Arctic, particularly if coastal habitat use by polar bears continues to increase (Sec. III.B.6.c. Marine Fissipeds – Polar Bear). As oil and gas activities along the coast expand from existing operations in the Beaufort Sea into the Chukchi Sea, the increased presence of both humans and bears in the coastal environment likely would result in increased bear-human interactions, especially if bears become nutritionally stressed as a result of continuing changes in sea-ice conditions; this will warrant closer monitoring and evaluation.

Since 1968, there has been only one documented case of a lethal take of a polar bear associated with oil and gas activities, at the Stinson site in the Alaska Beaufort Sea in 1990. Although the source was never determined, another bear died on an offshore island in the Alaska Beaufort Sea in 1988 after it ingested ethylene glycol. In contrast, 33 polar bears were killed in the Canadian Northwest Territories from 1976-1986 due to encounters with industry (Stenhouse, Lee, and Poole, 1988).

IV.C.1.h(6)(a) Conclusion. Recent information indicates that the Chukchi/Bering Sea polar bear stock is likely in decline due to illegal harvest in Russia (See Sec. III.B.6.c.). This means that the Maximum Sustained Yield, or the number of animals that can be sustainably removed from the population in any given year, also is reduced. Therefore, any bears lost to oil and gas activities would be a portion of bears lost to all causes, as outlined below, and likely would exceed sustainable levels, potentially affecting both bear productivity and subsistence use, and potentially causing a decline in the bear population (71 FR 14,458).

This assessment concludes that the effects of routine, permitted activities as a result of the Proposed Action, including seismic surveying, are expected to be slight, but concludes that the effects of accidental

spills could be significant. We note that 200,000 gal of oil (4,790 bbl) spilled onto the tundra as a result of an undetected leak in a corroded pipeline in March 2006 and, in August 2006, more than half of the Prudhoe Bay oilfield was shut down due to corroded and leaking pipelines. As vividly demonstrated by these events, small, chronic leaks in underwater pipelines could result in large volumes of oil being released underwater and under the ice cover without detection. The effects of a large oil spill, particularly during the broken-ice period, could pose significant risks to the polar bear population.

In summary, documented impacts to polar bears to date in Alaska by the oil and gas industry appear minimal. Due primarily to increased concentrations of bears on parts of the coast, the potential for a large oil spill to impact polar bear populations has increased in recent years. Oil spills have the greatest potential for affecting polar bears in part due to the difficulties involved in cleaning up spills in remote areas, given the wide variety of possible ice conditions. A large spill could impact large number of polar bears at coastal aggregations as well as in the broken pack ice and lead systems offshore. Polar bear aggregations on the Russian side also are vulnerable to oil-spill impacts. Therefore, our overall finding is that, due to the magnitude of potential mortality as a result of an oil spill, the Proposed Action could result in significant adverse impacts to polar bears.

IV.C.1.h(6)(b) Effects from 3D Seismic Surveys. Impacts to polar bears from marine open-water seismic activity have not been studied but likely would be minimal. When swimming, polar bears normally keep their heads above or at the water's surface, where underwater noise is weak or undetectable (Richardson et al., 1995a). Direct impacts potentially causing injury (Level A) from the seismic surveys are possible if animals entered the 190-dB zone immediately surrounding the sound source. However, with appropriate measures in place (e.g., marine mammal observers and shutdown procedures), any potential seismic-survey-generated injuries could be mitigated. There also is the possibility that bears could be struck by seismic vessels or exposed to small-scale fuel spills, although these risks are considered slight.

Polar bears are closely tied to the presence of the sea-ice platform for the majority of their life functions, including hunting (Amstrup, 2003). Because effective seismic surveys are relegated to operating in an ice-free environment, it is unlikely that the proposed activities would impact the abundance and availability of ringed and bearded seals, which are the primary prey of polar bears.

Seismic surveys have the potential to disturb polar bears that are swimming between icefloes or between the pack ice and shore. Swimming can be energetically expensive for polar bears, particularly for bears that engage in long-distance travel between the leading ice edge and land. Bears that encounter seismic operations may be temporarily deflected from their chosen path, and some may choose to return to where they came from. Therefore, although some bears may be temporarily deflected and or inhibited from continuing toward land due to seismic operations, this interruption likely would be brief in duration. For bears that are already severely energetically stressed, however, this could prove fatal. Due to the vast area covered by the seismic surveys and the fact that seismic operations will be curtailed during the bowhead migration (due to aggregations of migrating whales), which coincides with the time that large numbers of bears swim for land, the number of bears affected in this manner likely would be very small. Ultimately, few bears are likely to be substantially affected by seismic operations during the open-water period.

Because the proposed seismic operations will not be concentrated in any one area for extended periods, any impacts to polar bears should be relatively short in duration and should have a negligible impact on polar bear populations.

IV.C.1.h(6)(c) Effects from Exploration and Development. Past and future industrial developments along Alaska's arctic coast undoubtedly will increase the number of polar bear-human conflicts that occur, as the frequency with which polar bears come into contact with people and structures is a function of the amount of activity in their habitats. Even with the best mitigation measures in place, it is certain that some bears will be harassed or killed as a result of industrial activities in their habitat.

IV.C.1.h(6)(d) Effects from Noise and Disturbance. For most of the year, polar bears are not very sensitive to noise or other human disturbances (Amstrup, 1993). However, pregnant females and those with newborn cubs in maternity dens are sensitive to noise and vehicular traffic (Amstrup and Garner, 1994). Industrial developments onshore have the potential to disturb female polar bears in their maternal dens, where they are most sensitive to noise and vehicular traffic. Undisturbed denning habitat is critical to

polar bear reproductive success. More human activity along the coast and nearshore could reduce the suitability of some areas for use by denning female bears. Therefore, any proposals for onshore developments will have to include effective mitigation measures to avoid disturbance of denning bears.

Vessel traffic associated with exploration and development activity is not expected to cause impacts to polar bears, because they show little reaction to vessels and generally do not linger in open water. Brueggeman et al. (1991) observed polar bears in the Chukchi Sea during oil and gas activities and recorded their response to an icebreaker. While bears did respond (walking toward, stopping and watching, walking/swimming away) to the vessel, their responses were brief.

IV.C.1.h(6)(e) Effects from Oil Spills. Impacts to polar bears from oil and waste-product spills as a result of industrial activities in the Chukchi Sea are a major concern. Development of offshore production facilities and pipelines will be accompanied by the potential for large offshore spills. As far as is known, however, marine mammals have not been affected by oil spilled as a result of North Slope industrial activities, although at least one polar bear fatality has resulted from ingestion of industrial chemicals (Amstrup, Meyers, and Oehme, 1989). With the limited background information available regarding large oil spills in the offshore arctic environment, the outcome of a large oil spill is uncertain.

Between 1977 and 1999, an average of 70 oil and 234 waste-product spills occurred annually on the North Slope oil fields; and between 1985 and 1998, five large terrestrial spills occurred on the North Slope (71 *FR* 14456). In March 2006, approximately 201,000-267,000 gal of oil (4,786- 6357 bbl) leaked onto the tundra as a result of an undetected leak in a corroded pipeline and, in August 2006, more than half of the Prudhoe Bay oilfield was shut down due to corroded and leaking pipelines. As vividly demonstrated by these events, small, chronic leaks in underwater pipelines could result in large volumes of oil being released underwater without detection. If an underwater spill occurred during winter, the release of oil trapped under the ice during spring breakup would be equivalent to the catastrophic release of the same amount of oil (Amstrup, Durner, and McDonald, 2000). For the Proposed Action, the chance of one or more large spills occurring, based on OSRA analysis, is 40%. The chance of no spills occurring is 60%.

Spilled oil can have dramatic and lethal effects on marine mammals, as has been shown in numerous studies, and a large oil spill could have major effects on polar bears and seals, their main prey (St. Aubin, 1990a,b). In polar bears, oiling can cause acute inflammation of the nasal passages, marked epidermal responses, anemia, anorexia, stress, renal impairment, and death. These effects may not become apparent until several weeks after exposure to oil. Oiling of the pelt causes serious thermoregulatory problems for marine mammals by reducing its insulation value. Skin damage and hair loss also can occur (Oritsland et al., 1981). Because bears frequently groom their fur when it is fouled, we can expect that a spill in the Chukchi Sea would result in contaminated bears ingesting oil, and thus becoming susceptible to both lethal and chronic, sublethal effects of hydrocarbon exposure.

Spilled oil also can concentrate and accumulate in leads and openings that occur during spring breakup and autumn freezeup periods. The mechanical concentration of spilled oil in leads and openings in the ice would increase the chance that polar bears and their principal prey would be oiled (Amstrup, Durner, and McDonald, 2000). This also holds true during winter, because polar bears prefer the lead system at the shear zone between the shorefast ice and the active offshore ice. This narrow zone of moving ice parallels the coastline and creates openings that are used by seals. Thus, polar bears in winter use leads and openings in the ice where prey are most abundant and accessible (Durner et al., 2004). Consequently, they are more vulnerable to winter oil spills. Bears also are known to be attracted to petroleum products and can be expected to actively investigate oil spills and to consume foods fouled with petroleum products (Derocher and Stirling, 1991). In fact, one subadult polar bear in Canada was observed drinking an estimated four liters of hydraulic oil from a pail left outside of a building (Derocher and Stirling, 1991). Its subsequent fate was not determined.

Due to the seasonal distribution of polar bears, the times of greatest impact from an oil spill are summer and autumn (Amstrup, Durner, and McDonald, 2000). This is important because distributions of polar bears are not uniform through time. In fact, nearshore densities of polar bears can be two to five times greater in autumn than in summer (Durner and Amstrup, 2000), and polar bear use of coastal areas during the fall open-water period has increased in recent years in the Beaufort and Chukchi seas. This change in distribution has been correlated with the distance to the pack ice at that time of year (i.e., the farther from

shore the leading edge of the pack ice is, the more bears are observed onshore) (Schliebe et al., 2005; Kochnev, In prep.).

Polar bears aggregate along the coastline in the fall in areas where annual walrus haulouts are located, where beach-cast marine mammals are found, and where marine mammals have been harvested and butchered by Native hunters. Specific aggregation areas include the northern coast of Chukotka, Kolyuchin Island, Wrangel Island, Point Barrow, Cross Island, and Kaktovik (USDOI, FWS, 1999a; Kochnev, 2002; Kochnev, In prep). In recent years, as many as 140 polar bears have been observed feeding on walrus carcasses on Wrangel Island (Kochnev, 2002), and in the autumn of 2002, NSB and FWS biologists documented more than 100 polar bears that came ashore in and around Barrow (Schliebe et al., 2005). Such aggregations make polar bears more susceptible to oil-spill impacts. Polar bear concentrations also occur during the winter in areas of open water, such as leads and polynas, and areas where beach-cast marine mammal carcasses occur (USDOI, FWS, 1999a).

The impact of a large spill, particularly during the broken-ice period, could be significant to the polar bear population (65 *FR* 16833). The number of polar bears affected by an oil spill could be substantially higher if the spill spread to areas of seasonal polar bear concentrations, such as the north coast of Chukotka, Kolyuchin Island, Wrangel Island, or the area near Barrow, in the fall, and could cause a significant impact to the Chukchi/Bering Sea (CBS) polar bear population. Assuming a population of 2,000 bears, the Potential Biological Removal for the CBS stock, assuming an equal sex ratio for bears removed from the population, would be ~64 bears per year, of which no more than 32 could be females (Taylor et al., 1987). A spill near Barrow would affect both the Southern Beaufort Sea (SBS) and CBS stocks of polar bears.

Current human harvest of the CBS stock in Russia is believed to be above the maximum sustainable level; therefore, any mortality due to an oil spill would be additive. In the U.S., recent harvest levels (2000-2005) from the CBS stock averaged 41 individuals (11 female, 24 male, 6 unknown) (USDOI, FWS, unpublished data). However, recent illegal harvests in Russia are estimated to be as high as 250-300 bears per year (Ovsyanikov, 2003). This rate of harvest clearly is unsustainable, and the population most likely is in decline as a result.

Coastal areas provide important denning habitat for polar bears. Terrestrial denning areas for bears of the CBS polar bear stock are less well understood than those for the SBS polar bear stock. The highest density of denning known to occur in the Chukchi/Bering seas is on Wrangel Island, Russia, and along the northern coast of Chukotka (USDOI, FWS, 1999a). Radio-telemetry studies conducted in western Alaska indicate that all observed denning occurs north of Point Hope (USDOI, FWS, 1999a). However, traditional ecological knowledge indicates that some denning occurs on St. Lawrence Island and Little Diomedea Island, as well as along the coast between Wales and Barrow (Kalxdorff, 1997). Polar bear denning also occurs at Cape Lisburne; Cape Beaufort; the barrier islands between Point Lay and Peard Bay; the Kukpowruk, Kuk, and Sinaruruk rivers; Nokotlek Point; Point Belcher; Skull Cliff; and Wainwright Inlet. Although most polar bear denning in the Chukchi Sea occurs in Russia, traditional ecological knowledge indicates that denning may be more frequent along Alaska's Chukchi Sea coast than scientific studies have previously been able to quantify (USDOI, FWS, 1995; Kalxdorff, 1997). In addition, the distribution of denning areas may be changing as a result of climate change. Because of the importance of denning habitat to the population, identifying all known denning habitat is crucial when evaluating potential industrial activities.

Reproductive failure is known to occur in polar bears that den on unstable sea ice (Lentfer, 1975; Amstrup and Garner, 1994). If sea-ice extent in the Arctic continues to decrease (Sec. III.A.4) and the amount of unstable ice increases, a greater proportion of polar bears may seek to den on land (Durner, Amstrup, and Ambrosius, 2006). Those that do not may experience increased reproductive failure, which would have population-level effects. As a result, land denning likely would become more important in the future, which further highlights the importance of protecting sensitive terrestrial denning habitat, such as Wrangel and Herald islands.

The following paragraph discusses OSRA model estimates from LA1-13 and P1-P11.

Based on the OSRA model, if a large oil spill does occur, the highest chance of it contacting the Barrow area LS 85 during the summer open-water period within 10, 30, and 60 days is 4%, 9%, and 11%, respectively (Appendix A, Tables A.2-32, 33, and 34). During winter, the estimates for these same periods

are 1%, 2%, and 3% respectively (Tables A.2-56, 57, and 58). The highest chance of a large spill contacting the coast near Barrow after 180 days during winter is 7% (Table A.2-59). For the Russian Chukchi coast, including Wrangel and Kolyuchin islands (LS-95), the chance of a large spill contacting the coast during summer ranges from <0.5-13% over a period of 10-60 days (Tables A.2-38, 39, and 40). During winter, these figures are from <0.5-9% (Tables A.2-62, 63, and 64). Over a period of 180 days in winter, the chance of a spill contacting the Russian Chukchi coast is up to 29% (Table A.2-65). If a large spill did contact the shoreline, spilled oil could persist in sediments for more than a decade (USDO, MMS, 2003a:Sec. IV.C.2.a(3)(b)(2)).

The persistence of toxic subsurface oil and chronic exposures, even at sublethal levels, can have long-term effects on wildlife (Peterson et al., 2003). For example, as a result of the EVOS, oil persisted in surprising amounts and in toxic forms in coastal areas of southcentral Alaska and was sufficiently bioavailable to induce chronic biological exposures in animals for more than a decade, resulting in long-term impacts at the population level, particularly for species closely associated with shallow sediments (Peterson et al., 2003). Although it may be true that small numbers of bears may be affected by an oil spill initially, the long-term impact potentially could be much worse. Oil effects can be substantial over the long term through interactions between natural environmental stressors and compromised health of exposed animals, and through chronic, toxic exposure as a result of bioaccumulation (Peterson et al., 2003). Because polar bears are the apical predator of the arctic ecosystem and also are opportunistic scavengers of other marine mammals, and because their diet is composed mostly of high-fat sealskin and blubber, polar bears are biological sinks for lipophilic pollutants that biomagnify up the food chain (Norstrom et al., 1988). The highest concentrations of persistent organic pollutants in arctic marine mammals have been found in polar bears and seal-eating walruses (Norstrom et al., 1988; Andersen et al., 2001; Muir et al., 2000; Wiig et al., 2000). As such, polar bears would be very susceptible to the effects of bioaccumulation of contaminants associated with spilled oil, which would affect the bears' reproduction, survival, and immune systems (USDO, MMS, 2004:Sec. IV.E.2.e(1)(c)). Sublethal, chronic effects of any oil spill can be expected to suppress the recovery of polar bear populations due to reduced fitness of surviving animals. Sublethal doses of oil contaminants can cause delayed population impacts such as compromised health, growth, reproduction, and reduced survival in generations born after the spill (Peterson et al., 2003). Additionally, reductions in ringed seal numbers resulting from an oil spill could result in reduced polar bear recruitment and survival.

Oil spills in the Chukchi Sea associated with Sale 193 could affect both the SBS and CBS populations of polar bears, with the CBS population being arguably more vulnerable to oil-spill impacts. A major concern regarding a large oil spill is the impact it would have on the survival and recruitment rates of these polar bear populations. Both populations potentially would face synergistic impacts from human harvests, global climate change, increased shipping traffic, a declining prey base, drownings due to severe storm events, and increased levels of disease resulting from spending more time on land and concentrated at aggregation sites. Though the CBS and SBS populations may be able to sustain the additional mortality caused by a large oil spill, the effect of numerous bear deaths (i.e., 25-60) might significantly reduce population rates of recruitment and survival. Any bears lost to a large oil spill would be a portion of bears lost to all causes, as outlined above, and likely would exceed sustainable levels, affecting both bear productivity and subsistence use, and potentially causing a decline in the bear population (71 FR 14,458). For the bear population to be impacted in this manner, a large-volume oil spill would have to take place, the probability of which is 40% over the life of the project according to the OSRA analysis.

The dependence of polar bear life-history strategy on constantly high adult-survival rates causes polar bears to be particularly vulnerable to elevated levels of mortality. Being a *K*-selected species (i.e. exhibiting delayed maturation, small litters, and high adult survival rates [Bunnell and Tait, 1981]), polar bear populations are particularly sensitive to changes in survivorship, especially with regard to the reproductive female portion of the population. In fact, the survival rate of adult females is the predominant factor affecting population growth rates of polar bears, although other factors also may be important, such as cub survival, litter size, and age of first reproduction (Taylor et al., 1987). However, the critical issue when considering the long-term effect of any mortality on polar bear populations is the effect on numbers of breeding females. Assuming a realistic rate of natural mortality of approximately 5% per year, the annual increment of adult females would be between 1.0% and 1.6% of the total population. This annual increment is the number of adult females that can be sustainably removed from the population (Taylor et al., 1987). Under *optimal* conditions, the sustainable yield of adult female polar bears typically is <1.6% of

the total population (Taylor et al., 1987); for a population of 2,000, this would equate to <32 adult female polar bears per year. It should be noted that these projections are based on a “best-case” scenario and are representative of a population in a *favorable* environment and not experiencing other detrimental effects (Taylor et al., 1987). This is not the case for Alaskan polar bear stocks. Although no recent population estimate is available for the CBS population, all available data indicate that it is already in decline and that current levels of illegal harvest in Russia are unsustainable. Furthermore, recent information on changes in polar bear reproductive success, physical stature, and survival indicate that the status of polar bears in the Southern Beaufort Sea region is also changing (Regehr, Amstrup, and Stirling, 2006). In 2006, the SBS population was estimated at ~1,526 animals (Regehr, Amstrup, and Stirling, 2006) down from previous estimates of ~1,800 animals (Lunn et al., 2002). An unprecedented number of adult female polar bears have been found starved to death in recent years, and adult male body weights have declined. Survival rates of cubs of the year (COY) are now significantly lower than they were in previous studies, and there has also been a declining trend in COY size. Although many cubs are currently being born into the SBS region, more females are apparently losing their cubs shortly after den emergence, and these cubs are not being recruited into the population (Regehr, Amstrup, and Stirling, 2006).

Because populations pushed below their level of maximum sustained yield can become unstable due to stochastic environmental processes, long time periods can be required to recover from mass mortalities (Amstrup, 2000). Hence, recovery (recruitment) rates of polar bears from any mass mortalities would depend on environmental conditions (Taylor et al., 1987). The arctic environment undergoes large-scale fluctuations between and within years which, in turn, affects polar bear reproductive success (Taylor et al., 1987). The life-history strategy of polar bears is consistent with that predicted for animals that experience fluctuations in recruitment due to an unpredictable environment. Although polar bears are well adapted to their environment, they also are in a delicate ecological balance with it and, thus, susceptible to chronic and synergistic effects, as outlined above. Environmental instability affects the number of females available for breeding, and the number that actually produce offspring, by affecting their nutritional status and the survival rates of their cubs (Stirling, Andriashek, and Latour, 1975, Lentfer et al., 1980). Hence, there is not a steady rate of recruitment into the population. In fact, on average in Alaska, only 50-60% of polar bears survive to weaning at age 2½ (Amstrup, 2003), dependent upon environmental variables. However, recent information suggests that survival rates of COY in the SBS population are now significantly lower than they were in previous studies (Regehr et al., 2006).

Subadult polar bears are more vulnerable than adults to environmental effects (Taylor et al., 1987). Observations of density-dependent and density-independent effects on populations of other marine mammals indicate that environmental effects typically are manifest first as reductions in annual breeding success and reduced subadult survival rates (Eberhardt and Siniff, 1977). Subadult polar bears would be most prone to the lethal and sublethal effects of an oil spill due to their proclivity for scavenging (thus increasing their exposure to oiled marine mammals) and their inexperience in hunting. Subadults also are the age strata that most often become “problem bears.” As problem bears, they have reduced expectations of survival. Problem bear mortality may be of increasing significance as northern development proceeds (Taylor et al., 1987). Because of the greater maternal investment a weaned subadult represents, reduced survival rates of subadult polar bears have a greater impact on population growth rate and sustainable harvest than reduced litter production rates (Taylor et al., 1987). Likewise, adult females are especially important to population growth rates because reproductive maturity indicates survival through the vulnerable subadult period.

IV.C.1.h(7) Benefits of the Standard Mitigation. Potential impacts to polar bears are an increasing concern because of ongoing changes in their sea-ice habitat, their distribution, and the uncertain status of their populations (Sec. III.B.6). Given the proposed listing of polar bears as a threatened species under the ESA, MMS will work in close coordination with FWS as listing occurs to further review and identify the specific oil and gas activities that are likely to affect polar bears and identify mitigation and monitoring measures that seek to reduce the potential for impacts to occur.

Because of the widespread occurrence of marine mammals in Alaskan waters, including endangered species, and the increasing level of proposed offshore activities, MMS and other agencies are scrutinizing the potential for oil- and gas-related activities to involve incidental takes. The taking of small numbers of marine mammals is subject to the requirements of the MMPA and ESA. 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 a small number of marine mammals incidental to a specified activity within a specified geographical area. Procedural regulations implementing the provisions of the MMPA are found at 50 CFR 18.27 for FWS and at 50 CFR 228 for NMFS. Under the MMPA, OCS operators can apply to FWS for an Incidental Take Authorization (ITA) for polar bears. Lessees are encouraged to discuss proposed activities with the MMS and FWS to determine if there is a potential for incidental takes and the timing and process for obtaining either an Incidental Harassment Authorization (IHA) or Letter of authorization (LOA). The regulatory process to obtain an LOA or IHA may require 1 year or longer.

The MMS regulations require operators to submit OSRP's with proposals for exploration and/or development (CFR 250.203, 204, and 254). The OSRP's must identify methods to protect marine and shoreline resources (30 CFR 254.23), including polar bear aggregations onshore.

In the past, the response plans for the proposed lease area have relied on equipment that is stored near Prudhoe Bay. Portions of the proposed lease-sale area near Barrow where polar bears congregate on the coast are remote from this response equipment. If there are proposed operations in these remote areas, operators must provide additional response measures to protect polar bears. One such measure might be the prestaging of response equipment near Barrow and/or the training of response teams in local communities. In the event of an oil spill, polar bears would be intentionally hazed to keep them away from the spill area, if possible. Care must be taken during response operations, however, to prevent spill-response and/or hazing activities resulting in polar bears being pushed into oiled areas or inhabited areas.

Additional mitigation is provided by three standard ITL's: ITL No. 2, Information on Bird and Marine Mammal Protection; ITL No. 14, Information on Planning for Protection of Polar Bears; and ITL No. 8, Information on Sensitive Areas to be Considered in Oil-Spill-Response Plans. ITL No. 2 advises lessees that they are subject to the MMPA and ESA during the conduct of their operations. The ITL No. 2 also encourages lessees to "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." This ITL has been modified to also emphasize polar bears. The ITL No. 2 also notes that disturbance at "major wildlife concentration areas" are of "particular concern", and that "maps depicting major wildlife concentration areas in the lease area are available from the RS/FO." However, MMS must ensure that these maps are current and provide complete coverage of the lease area for them to provide effective polar bear protection. This emphasizes the need for clear channels of communication with FWS to ensure that MMS decisions are based on the most current information available. This need was explicitly addressed in the Regional Director's letter to Regional Supervisors dated September 5, 2006, regarding MMS' intention to cooperate with FWS in the future on designing effective mitigation measures for polar bears. The ITL No. 14 advises lessees on how to conduct their activities to specifically reduce impacts to polar bears. The ITL No. 8 has been expanded to include a statement that coastal aggregations of polar bears during the open-water/broken-ice period are particularly vulnerable to the effects of an oil spill, which lessees must account for in their OSRP's.

IV.C.1.h(8) Effectiveness of Mitigation Measures. In Alaska, oil leasing and production are accompanied by stipulations and mitigation measures. The strength of those requirements and a realistic assessment of their effectiveness must be included in any risk analysis (Amstrup, Durner, and McDonald, 2000). Polar bears are part of a dynamic rather than a static system. Changes in their distributions and populations in recent years indicate that adaptive management is required to adequately mitigate potential impacts to their populations (i.e., specific mitigation measures developed today may not be applicable 5, 10, or 20 years from now). Because FWS is the agency responsible for polar bear management, they have the most current information about the status of polar bear populations, the issues facing them, and the most recent research findings applicable to them. Therefore, clear channels of communication with FWS must be established and maintained to effectively mitigate potential oil-spill effects and to ensure that MMS decisions are based on the most current information available. Given the proposed listing of polar bears as a threatened species under the ESA, MMS will continue to work in close coordination with FWS as listing occurs to further review and identify the specific oil and gas activities that are likely to affect polar bears and identify mitigation and monitoring measures that seek to reduce the potential for impacts to occur.

The MMS is aware of recent decreases in summer sea ice and changes in polar bear distribution and habitat use—particularly in their tendency to aggregate near Point Barrow, Wrangel Island, and on the north coast of Chukotka in autumn. Because any exploration, development, and production activities that take place in the Chukchi Sea almost certainly would result in the taking of marine mammals, for which operators and their subcontractors without a valid ITA would be liable under the MMPA, operators are strongly encouraged to obtain LOA's from FWS. If an OCS operator applies for an ITA, the FWS would have an opportunity to review the corresponding Exploration Plan (EP) or Development and Production Plan (DPP). This may help mitigate impacts to polar bears and subsistence activities. If an operator chooses not to obtain an ITA, MMS intends to meet with FWS and the operator to discuss the operator's liability under the MMPA, as well as what type of mitigation, monitoring, and reporting requirements are appropriate, given the changing environment and most current status of the polar bear stock.

To adequately mitigate potential oil-spill impacts, MMS must ensure that operators' OSRP's address protection of polar bears, in consultation with FWS. As required by our regulations (30 CFR 250.241(g)), MMS will make copies of any DPP's available to FWS and other appropriate Federal Agencies so that they will have an opportunity to review the DPP's and comment on them. We acknowledge that MMS regulations with regard to the distribution of EP's are not similar (30 CFR 250.211(f)). However, the Regional Supervisor Field Operations will make copies of EP's (and associated OSRP's) available to FWS and other appropriate Federal Agencies for review and comment to ensure that potential threats to polar bears are adequately addressed and mitigated, based on the most current knowledge regarding their habitat use, distribution, and population status. This protocol has been clearly outlined in the new ITL No. 14, Information on Planning for Protection of Polar Bears, as well as in a letter from the MMS Alaskan Regional Director to Regional Supervisors and the FWS dated September 5, 2006.

The MMS has acknowledged that there are difficulties in effective oil-spill response in broken-ice conditions. The MMS advocates the use of nonmechanical methods of spill response, such as in situ burning, during periods when broken ice would hamper an effective mechanical response. In situ burning has the potential to rapidly remove large quantities of oil and can be employed when broken-ice conditions may preclude mechanical response. However, there is a limited window of opportunity (or time period of effectiveness) to conduct successful burn operations. The type of oil, prevailing meteorological and oceanographic conditions, and the time it takes for the oil to emulsify define that window. Once spilled, oil begins to form emulsions. When water content exceeds 25% most slicks are unignitable (<http://www.mms.gov/tarprojectcategories/insitu.htm>). Reducing the chance of oil spills in the first place and responding effectively to spills, as summarized in Section IV.A.4, plus discouraging human-induced polar bear congregations during the fall open-water period, all need to be part of the solution.

Increasing trends in polar bear use of terrestrial habitat in fall are likely to continue. The MMS realizes that some OCS operations might pose a relatively high spill risk to polar bear aggregations and, therefore, to the polar bear population as a whole. In March 2006, more than 200,000 gal (4,790-bbl) of oil spilled onto the tundra on the North Slope as a result of a leak in a corroded pipeline that went undetected for an extended length of time. As demonstrated by this spill, small, chronic leaks in pipelines can result in large volumes of oil being released underwater without detection. If such a spill occurred in an underwater pipeline during winter, the release of oil trapped under the ice during spring breakup would be equivalent to the catastrophic release of the same amount of oil (Amstrup, Durner, and McDonald, 2000). Polar bears would be extremely vulnerable to oil-spill effects in the broken pack ice and lead system offshore. If such an event occurred in offshore waters, the impacts to the polar bear population potentially would be significant. The risk of such an event is not negligible over the lifetime of proposed developments. The continued use of new technology, such as the LEOS leak-detection system, can greatly enhance the ability to detect small leaks so they do not become large spills over time. The MMS regulations require spill prevention and equipment monitoring measures to reduce the likelihood of spills and improve the responses to them, as summarized in Section IV.A.5. As demonstrated by the Prudhoe Bay oil field shutdown in August 2006, however, low volume spills still can go undetected for a substantial amount of time. Such a spill from an underwater pipeline likely would result in a substantial amount of oil being released into the marine environment.

For the Proposed Action, the chance of one or more large spill occurring, based on OSRA analysis, is 40%. This figure represents the chance of one or more large spills for the Proposed Action and alternatives based on the mean spill rate over the life of the project. If a large oil spill does occur, there is as much as an 11%

chance that an oil spill would contact the coast near Barrow (LS 85) within 60 days (Table A.2-34). For the Russian Chukchi coast (LS 95), this figure is 13% (Table A.2-34). Over a period of 180 days in winter, the chance of a spill contacting the Russian Chukchi coast is 29% (Table A.2-65).

To adequately protect polar bears and their habitat from the threat of a large oil spill, the mitigation measures currently in place must be adaptable to continued changes in polar bear distribution and habitat use. Considering the distances involved and the vagaries of the weather along the Chukchi Sea coast, personnel and equipment based in Prudhoe Bay may be unable to respond to oil spills in the Chukchi Sea in a timely and efficient manner. Equipment and trained crews will need to be located to respond to a spill as soon as it is discovered. Depending on the location of the activity and time of year, prestaging oil-spill-response equipment in Barrow, offshore facilities, or other locations could greatly reduce the chance that an oil spill would enter a sensitive area and oil polar bears there, and also would allow a quicker response to any spills that occur in remote portions of the sale area.

These initiatives have been added to a new ITL to ensure adequate geographic coverage and protection of polar bears within the sale area in the event of an oil spill (Sec. II.B.3). If operations occur in areas with the potential to impact polar bear aggregations, the prestaging of boom material and other pertinent response equipment may be included in the OSRP or in the final Condition of Permit approval letter for a production project issued by the RS/FO.

As a result of the information considered here, we conclude that if an offshore oil spill occurred, a significant impact to polar bears could result, particularly if areas in and around polar bear aggregations were oiled. Polar bears also would be extremely vulnerable to oil-spill effects in the broken pack ice and lead system offshore during winter and spring, because the biological potential for them to recover from any perturbation is low due to their low reproductive rate (Amstrup, 2000). For the Proposed Action, the chance of a large spill occurring, based on OSRA analysis, is 40%. This figure represents the chance of one or more large spills for the Proposed Action and alternatives based on the mean spill rate over the life of the project. However, in the event of an oil spill, the chance of oil contacting a polar bear aggregation within 60 days is relatively low (<13%), according to OSRA analysis. Polar bears in offshore habitat, such as broken pack ice and the lead system, however, would be particularly vulnerable to large spills.

Reducing the concentrations of polar bears onshore in fall would be one possible way to mitigate potential oil-spill impacts. This could be accomplished by removing the remains of Native-harvested whales from the beaches outside of Native villages. However, the whale remains are on Native-owned lands; thus, that decision will have to be negotiated with the Native communities themselves. The FWS and USGS scientists have been advocating this approach for some time, and are very aware of the benefits of discouraging concentrations of polar bears on land in the fall. Discouraging congregations of polar bears on land during the fall open-water period, by properly disposing of Native-harvested whale carcasses, would substantially lower the potential impacts to polar bears and enhance the effectiveness of mitigation. However, it is not possible to discourage polar bear aggregations at walrus haulouts on the Russian side. Mitigation of potential impacts to these sites will require collaboration and cooperation between Russian and U.S. officials. If mitigation such as prestaging oil-spill-response equipment and training response crews in Barrow were adopted, the level of effect on polar bears might be moderated.

In summary, documented impacts to polar bears to date in Alaska by the oil and gas industry appear minimal. Due primarily to increased concentrations of bears on part of the coast, the potential for an oil spill to impact polar bear populations has increased in recent years. Oil spills have the greatest potential for affecting polar bears in part due to the difficulties involved in cleaning up spills in remote areas, given the wide variety of possible ice conditions in the Chukchi Sea. A large oil spill could impact large numbers of polar bears at coastal aggregations as well as in the broken ice and lead systems offshore. Polar bear aggregations on the Russian side also are vulnerable to oil-spill impacts. Therefore, our overall finding is that, due to the magnitude of potential mortality as a result of an oil spill, the Proposed Action could result in significant adverse impacts to polar bears.

IV.C.1.i. Terrestrial Mammals.

This section assesses the effects on terrestrial mammals as a result of the Proposed Action (Alternative I), and includes analyses of the effects due to disturbance, including disturbance due to seismic surveys and the effects due to large oil spills.

IV.C.1.i(1) Conclusion. Among the terrestrial-mammal populations that could be affected by oil exploration and development in the Sale 193 area are: caribou of the Central Arctic (CAH), Western Arctic (WAH), and Teshekpuk caribou (TCH) herds; muskoxen; grizzly bears; and arctic foxes. 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. Effects could also come from potential oil spills contacting coastal areas used by caribou for insect relief and scavenging by grizzly bears and arctic foxes.

The effects of Chukchi Sea OCS exploration and development on caribou, muskoxen, and grizzly bears would likely include local displacement within about 4 km of onshore pipelines and roads (Cameron et al., 2005). If an oil spill occurred in the Chukchi Sea, it likely would result in the loss of a small number of caribou, muskoxen, grizzly bears, and arctic foxes.

However, significant impacts to local grizzly bear populations could occur if a large oil spill affected one of the salmon-spawning rivers in the project area. Also, because large aggregations of caribou are known to wade into coastal waters during mid-July to early August, a proportion of any of the three caribou herds that use the area could be impacted by offshore oil spills that occur during the insect-relief season.

IV.C.1.i(2) Effects from 3D/2D Seismic Surveys. The effects from 3D/2D seismic surveys are primarily related to aircraft and other activities that are necessary for the surveys and are described as disturbances in section IV.C.1.i(3).

IV.C.1.i(3) Effects from Exploration and Development.

IV.C.1.i(3)(a) 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.

Disturbance of caribou associated with exploration activities would come primarily from helicopter traffic. Caribou have been shown to exhibit panic or violent flight reactions to aircraft flying at elevations of 60 m (162 ft) or less and exhibit strong escape responses (animals trotting or running from aircraft) to aircraft flying at 150-300 m (500-1,000 ft) (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 have no effect on caribou herd distribution and abundance.

Tolerance to aircraft, ground-vehicle traffic, and other human activities has been reported in several studies of ungulate populations in North America including caribou (Davis, Valkenburg, and Reynolds, 1980; Valkenburg and Davis, 1985; Johnson and Todd, 1977). 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 CAH (USDOI, MMS, 2003a). It is uncertain how caribou of the Teshekpuk Lake Caribou Herd (TCH) will respond, given that it is a "naive" herd, i.e., one that has been exposed to little aircraft or vehicular traffic.

Research has suggested that caribou in arctic Alaska generally avoid areas within 4 km of oil-field roads after they are constructed (Cameron et al., 1992; Joly, Nellemann, and Vistness, 2006). However, some have suggested that avoidance is not absolute, and that caribou may habituate to infrastructure and human activity (Haskell et al., 2006). Conversely, research at Milne Point has shown that since 1987, there has been a southward shift of the calving grounds away from the oil-field study area. This has been attributed to the development of roads and pads in the calving grounds, which placed 92% of the study area within 4 km of developments. The remaining undisturbed fragments were too small for continued use for concentrated calving (Joly, Nellemann, and Vistness, 2006).

Understanding gross processes of habituation by caribou may aid in land management decisions and development of effective mitigation measures for industry and wildlife management agencies (Haskell et al., 2006). Haskell et al. (2006) argue that caribou habituation to oilfields recurs annually and is positively correlated with the timing of spring snowmelt. Vehicular movement may evoke an unconditioned response to perceived predation risk (Frid and Dill, 2002). Therefore, minimizing traffic, especially within calving areas during the calving period, would reduce the potential for negative synergistic impacts on caribou. To maximize efficacy without overregulation, calving period-specific mitigation measures in established oil fields might be terminated or extended, based on the timing of spring snowmelt (Haskell et al., 2006).

Cronin, Whitlaw, and Ballard (2000) state that the coexistence of caribou with oil and gas development demonstrates the success of mitigation, regulation, and management efforts, which should be acknowledged in environmental impact statements, environmental assessments, and planning for new developments. Cronin, Whitlaw, and Ballard (2000) acknowledge that oil development may affect caribou in some manner. However, they maintain that impacts have not resulted in negative population-level effects, and that the CAH has grown throughout the period of oil-field development at a rate comparable to other herds in undeveloped areas (Ballard, Cronin, and Whitlaw, 2000).

Conversely, from the mid-1970's through the mid-1980's, use of calving and midsummer habitats by CAH caribou declined near oil-field infrastructure on Alaska's Arctic Coastal Plain (Dau and Cameron, 1986). Abundance and movements of females were lower in the oil field complex at Prudhoe Bay than in other areas along the Arctic coast (Cameron et al., 2005). Conservative calculations yielded an estimated 78% decrease in use by caribou and a 90% decrease in their east-west movements in the oil fields (Cameron et al., 1995), apparently in response to intensive development of that region over the past three decades (Cameron et al., 2005). In the Kuparuk Development Area, west of Prudhoe Bay, abundance of calving caribou was less than expected within 4 km of roads and declined exponentially with road density (Cameron et al., 2005). With increasing infrastructure, high-density calving shifted from the Kuparuk Development Area to inland areas with lower forage biomass. As a result, female caribou exposed to petroleum development west of the Sagavanirktok River may have consumed less forage during the calving period and experienced lower energy balance during the midsummer insect season than those under disturbance-free conditions east of the river. The probable consequences of this were poorer body conditions at breeding and lower parturition rates for western females than for eastern females, which depressed the productivity of the herd.

However, the CAH has grown since the beginning of the Prudhoe Bay oil-field development, from an estimated 5,000 animals in 1975 (Cameron and Whitten, 1979) to about 27,000 animals in 2000 (Lenart, 2003). Recent increases (1998-2000) were due to low adult mortality (<10%), high parturition rates (>90%), and high calf survival to October (>50 calves:100 cows) (Lenart, 2003). The variability of the herd's recent high rates of net productivity (Lenart, 2003) has been shown to be strongly correlated with environmental factors (Haskell and Ballard, 2004). Although there may be some disturbance of animals in the oil fields, population-level impacts apparently have not occurred (Cronin, Whitlaw, and Ballard, 2000). Some have suggested that changes in numbers of caribou in areas with and without oil fields probably are due to movements between summer ranges rather than from oil-field impacts. They also point out that the management objectives for the CAH have been met despite development of the largest oil and gas fields in the United States (Cronin, Whitlaw, and Ballard, 2000).

IV.C.1.i(3)(b) 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 ft (180 m), 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 mi (4 km) from the operations; however, reactions by muskoxen were highly variable among individuals, with some individuals not reacting at very close distances (0.12 mi [0.2 km]) (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 mi (5 km) 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 ft (100 and 400 m) with response durations lasting from 2-12 minutes (Miller and Gunn, 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 concentrate and feed in riparian areas, especially in the winter months. 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.

IV.C.1.i(3)(c) 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 are 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 mi (1.8 km) 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 ft of the den may cause abandonment of the den. Human scent and other noises also may disturb the bears.

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 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). Some bears are likely to habituate to human noise and presence, leading to an increase in encounters. People often will not accept the risk of bear attacks, and these encounters often lead to the loss of bears (Archibald, Ellis, and Hamilton, 1987). However, individual bears vary in the degree of habituation-tolerance to human presence, and some will continue to avoid areas where 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 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). 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 being killed near settlements and camps in human-bear encounters.

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.1.i(3)(d) General Effects of Disturbance to the 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). Crawlspace 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). Localized seismic and oil-development activities do not appear to have any dramatic, deleterious effect on fox populations (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.1.i(4) Effects from Development and Production.

IV.C.1.i(4)(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.1.i(4)(b) Effects from Pipelines. The Western Arctic Caribou herd (WAH) can be considered a “keystone” population, in that it provides critical resources for many other species sharing the ecosystem and is an important subsistence resource for as many as 40 Native villages within the herd’s annual range (Schoen and Senner, 2003). Therefore, careful consideration must be given to the impact of potential developments to this herd as well as to the Central Arctic Herd (CAH) and Teshekpuk Lake Caribou Herd (TCH).

Some Alaskan 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., 1983a). Some Natives from Kaktovik have noticed that caribou overwintering on the North Slope have become scarce since development of the oil fields (Rexford, 1982). Recent studies (Roby, 1978; Cameron, Whitten, and Smith, 1981, 1983; Cameron et al., 1992; Pollard and Ballard, 1993; Joly, Nellemann, and Vistness., 2006) indicate significant seasonal avoidance of habitat near (within 4 km [2.4 mi]) some existing Prudhoe Bay area facilities by cows and calves during calving and early postcalving periods (May through June). For example, abundance of calving caribou in the Milne Point area declined significantly with progressive development (Noel, Parker, and Cronin, 2004; Joly, Nellemann, and Vistness, 2006). In the Milne Point area, Joly, Nellemann, and Vistness (2006) found that there has been a gradual abandonment of developed areas of the oilfield during calving and a drop in abundance of calving caribou by at least 72% within the oil field, despite the fact that the CAH herd size has increased 4- to 5-fold during the same period (1978-2000). Since 1987, there has been a southward shift of the calving ground away from the oil-field study area. This has been attributed to the development of roads and pads in the calving grounds, which placed 92% of the study area within 4 km of the developments. The remaining undisturbed fragments were too small for continued use for concentrated calving (Joly, Nellemann, and Vistness, 2006). Proportionately, in relation to a herd that increased 4- to 5-fold, the decline is much larger (Joly, Nellemann, and Vistness, 2006).

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 of the caribou’s summer range. However, caribou abundance and overall distribution have not been affected, and the CAH 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 7 ft above the tundra, a requirement for onshore pipelines in the NPR-A (USDOI, BLM, 2006). Pipelines without adjacent roads and vehicle traffic are not likely to affect caribou movements.

These findings suggest that caribou are able to habituate and adapt to oil-field infrastructure, and that significant impacts to caribou herds on the North Slope as a result of the Proposed Action are not likely.

IV.C.1.i(4)(c) Effects from 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 of habitat available to the caribou herd and muskox populations. The construction of roads and gravel pads also may provide caribou with additional insect-relief habitat, particularly when there is little or no road traffic present. Conversely, the construction of roads and pipelines could provide vectors by which invasive species and new diseases could be introduced into the arctic environment (Kutz et al., 2004; Urban, 2006). Baseline studies should be conducted prior to any onshore construction activities to determine the location and extent of calving areas and insect-relief areas.

Among the terrestrial-mammal populations that could be affected by onshore pipeline construction are caribou of the TCH and WAH. Some WAH 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.1.i(4)(c)1 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 of the project area during the winter months when gravel will be mined, but small bands may be present.

Muskoxen also use riparian (river) habitats on the North Slope, where gravel-mining sites may be located.

IV.C.1.i(4)(c)2 Effects of Habitat Alteration on Arctic Foxes. Arctic foxes could benefit from development in the Chukchi Sea area. Crawlspace 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 project area and in nearby undeveloped areas (Burgess et al., 1993).

IV.C.1.i(4)(c)3 Effects of Site-Specific Onshore Development. Assuming oil development takes place in the Chukchi Sea, 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 pipeline landfalls at yet to be determined sites.

IV.C.1.i(4)(d) Effects from Oil Spills.

IV.C.1.i(4)(d)1 Effects from Small Oil Spills. Over the production life of the sale, small crude oil spills (3 bbl) and 440 small refined oil spill (average of 0.7 bbl) are estimated to occur (Appendix A, Tables A.1-29 and A.1-32). 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 (Kuopat 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 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 are not likely to directly affect caribou or muskoxen through ingestion of oiled vegetation.

IV.C.1.i(4)(d)2 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. Large aggregations of caribou are known to wade into coastal waters during mid-

July to early August. Therefore, a large proportion of any of the three caribou herds that use the area could be impacted by any large offshore oil spills that occur during the insect-relief season. 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. 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. 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.

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 Chukchi Sea coast, some grizzly bears and 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).

An oil spill in a coastal river would have similar, though greater, impacts to local grizzly bear populations, particularly if it occurred during an active salmon run. Rivers (and dates of active runs) with salmon on the Chukchi coast include: Kugrua River (May-Oct.), Kuchiak River (Jan.-Dec.), Kuk River (May-Oct.), Kokolik River (May-Oct.), Kukpowruk River (May-Oct.), Pitmegea River (May-Oct.), and Utukok River (May-Oct.).

IV.C.1.i(4)(d)2)a) Site-Specific Effects of a Large Oil Spill. The OSRA model estimates the chance of one or more large oil spills occurring during development is 40%. The most likely number of large spills is zero.

In the event that a 1,500-bbl or 4,600-bbl platform or pipeline oil spill occurred during the open-water season or during winter and melted out of the ice during spring, some caribou that frequent coastal habitats could be directly exposed to and contaminated by the spill along the beaches and in shallow waters during periods of insect-pest-escape activities. 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.

IV.C.1.i(4)(d)2)b) 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 also result in

the loss of small numbers of grizzly bears and arctic foxes through ingestion of contaminated prey or carrion.

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 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 would be most intense during the construction period, 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.

The OSRA model estimates the chance one or more oil large spills occurring during development is 40%. The most likely number of large spills is zero. A large oil spill (1,500 or 4,600 bbl) could most likely cause the loss of small numbers of caribou, muskoxen, grizzly bears, and arctic foxes.

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.

However, significant impacts to local grizzly bear populations could occur if a large oil spill affected one of the salmon-spawning rivers in the project area.

IV.C.1.i(5) Effectiveness of Mitigation Measures. The ITL 2 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.1.j. Vegetation and Wetlands.

The most likely effects of oil activities on vegetation and wetlands would be from development and production activities. The required installation of a shorebase facility to support offshore operations would have minor impacts on some of the plant communities established along the coast. These impacts would be localized and would include loss of tundra acreage, damage of vegetation cover, shift in species composition, and introduction of noxious weeds.

In the event that oil production would be transported through a pipeline system connecting to the TAPS or a nearer gathering point (for example in the NPR-A), impacts on inland terrestrial plant communities and palustrine wetlands also would occur. These impacts would result from the likely construction and maintenance of pump stations, pipelines, vertical supports, and communication lines along a 300-mi pipeline corridor stretching eastward. Impacts on vegetation due to gravel borrow pits, gravel pads, and gravel roads also would be expected from the construction of both the pipeline system and the shore-base facility.

Impacts on tundra vegetation and palustrine wetlands due to small oil spills and small discharges (saline water, hydraulic fluids, and diesel) are likely to be minor, because these spills would be localized and in small quantities. Long-term impacts on vegetation and wetlands could occur as a consequence of a large oil spill. Inland, a large oil spill could reach larger areas and go deeper into the vegetation root mat, requiring longer time to recover. Long-term effects on coastal estuaries and saltmarshes would be expected only if a large oil spill occurring offshore would happen under such severe climatic conditions and close enough to the coastline that spill would reach the coast before cleanup operations are set in place. The

OSRA model estimates a 7% chance of one or more spills occurring and contacting land and a <0.5-1% chance of contacting individual land segments within 30 days (Appendix A.2 ; Tables A.2-75 A.2-81. Cleanup operations may reduce the chance of a large spill contacting land. (See Section IV.A.4.a for a discussion of the likelihood of the occurrence of a large oil spill).

IV.C.1.j(1) Conclusion. Seismic surveys and exploration activities would be concentrated offshore, with no impacts to onshore and inland vegetation and wetlands. The level of effects on wetlands and terrestrial vegetation communities resulting from oil development and production likely would be localized. These impacts would be moderate to significant at a local scale, especially if a large spill would occur, but would have a small effect on the ecological functions, species abundance and composition of wetlands and plant communities of the North Slope at a regional scale.

IV.C.1.j(2) Effects from 3D Seismic Surveys. Negligible impacts would be expected on vegetation communities during the 3D seismic-surveys phase, as all exploration activities would be conducted offshore. Because no drilling would be conducted during this phase and there would be no direct effects on vegetation.

IV.C.1.j(3) Effects from Exploration Activities. This phase would include drilling deep test wells using drillships with icebreaker support vessels. During this phase, no impacts on vegetation communities would be expected, as the risk for oil spills during the installation of testing wells is almost nonexistent. Also, all exploration activities would be conducted offshore. The probability of a large spill or blowout is low, as is the possibility of a large spill reaching the coast.

IV.C.1.j(3)(a) Disturbance. This phase would not require any onshore activities. Therefore, direct disturbance on plant communities along the Chukchi Sea shoreline (saltmarshes, estuaries, and sand-dune vegetation) would be unlikely.

IV.C.1.j(3)(b) Discharges. Discharges would be expected to be minimal and likely would be small quantities of diesel, gasoline, and hydraulic fluids spilled during maintenance and operation of equipment on suspended wells or bottom-founded platforms. A pollution prevention plan to minimize discharges directly into the water would be implemented. Due to potential low quantities of these discharges, negative impacts on shoreline vegetation communities would be negligible.

IV.C.1.j(3)(c) Noise. Noise in general does not have negative effect on vegetation; therefore, noise produced during offshore exploration activities would have not impact whatsoever on onshore or inland vegetation communities or wetlands.

IV.C.1.j(3)(d) Small Oil Spills (less than 1,000 barrels). Due to amendments in the OCS Lands act, strong safety and pollution-prevention regulations, and the use of blowout-prevention equipment installed on seabed wellheads, the potential for oil spills has diminished greatly. Therefore, impacts on shoreline vegetation would be expected to be low as a consequence of the implementation of these prevention measures. Another reason for diminished impacts of shoreline vegetation resulting from small oil spills, would be the distance from the shoreline in which the exploration activities take place.

IV.C.1.j(4) Effects from Development Activities. Development activities would start only if a commercially viable quantity of oil is discovered. All precautionary measures would be implemented to avoid adverse negative impacts on critical wetlands and arctic vegetation during the development and production phases. The impact analysis on vegetation includes a wide array of foreseeable impacts on palustrine wetlands and tundra vegetation that may or may not occur, but are included to cover each possible scenario. Reasonably foreseeable impacts would be localized and would not adversely affect the functions of wetland ecosystems at a regional scale.

IV.C.1.j(4)(a) Disturbance. Foreseeable negative impacts on terrestrial vegetation communities would be caused by the construction of the shore-base facility, pipelines, maintenance roads, and ice pads, gravel borrow pits, gravel pads, and gravel roads built along the 300-mi eastward corridor. Disturbances include loss of tundra vegetation acreage, damage or destruction of vegetation cover, shift in plant species composition, introduction of noxious weeds, as well as effects of public access to isolated vegetation communities.

IV.C.1.j(4)(a)1) Loss of Tundra Vegetation Acreage. Tundra vegetation cover would be removed permanently in areas where gravel borrow pits would be established and where pipelines would be buried. Pipeline burial under tundra has been the exception on the North Slope rather than the norm, and it is expected that substantial lengths of buried pipeline would be an unlikely event. Tundra vegetation also would be buried under gravel pads established for the construction of pump stations and under gravel roads and runways. Communication lines and vertical supports also would require the removal or burying of tundra vegetation. Buried vegetation likely would die.

IV.C.1.j(4)(a)2) Damages on Vegetation Cover. Vegetation cover likely would be damaged by roadside dust and compression caused by ice pads and ice roads.

Roadside dust produced by gravel roads is known to cause loss of vegetation, specifically of mosses typically found on acidic tundra. Sphagnum moss is particularly sensitive to the toxic effects of calcium in the dust; a significant reduction or elimination of sphagnum moss, especially in the 0-10 m adjacent to the road, has been reported in acidic tundra (Walker et al., 1987). Mosses promote low soil temperatures and permafrost development by conducting heat under cool, moist conditions and by insulating soils under warm, dry conditions (Oechel and Van Cleve, 1986). The loss of vegetation near the road is, to some extent, responsible for the extensive thermokarst features developed along older roads. Mosses are a large component of the vegetation found at the west side of the North Slope; among the common ones are sedge/grass, moss wetlands (W1), sedge/moss/dwarf shrub wetlands (W2), and tussock-sedge/dwarf shrub/moss tundra (G4). Another impact is the earlier meltdown of the snow drift accumulated near roads, because the darker dust covering snow surfaces absorb more heat. Earlier meltdown could provide early open areas to wildlife several days or weeks before adjacent snow-covered tundra becomes accessible. The use of chip-seal treatment (an application of asphalt followed with an aggregate rock cover) of roads could dramatically reduce the impacts of roadside dust generation (NRC, 2003b) in roads designed to be permanent.

IV.C.1.j(4)(a)3) Changes in Plant-Species Composition. Changes in vegetation likely would occur by roadside water impoundment, changes in soil hydrology, and thermokarst effects. Permanent gravel pad substrates also would have impacts on plant communities, as they would greatly differ from adjacent substrates. If colonized, gravel pads would be composed by a set of completely different plant species.

Although all precautionary measures would be implemented to avoid negative impacts on critical wetlands, localized long-term impacts would be expected due to the construction of gravel roads and gravel pads. Because old, breached lakes are abundant in the Proposed Action area, gravel-road layouts likely would require the crossing of these low-lying, drained thaw-lake basins. Drainage systems on flat tundra are complex and have several unconnected drainage ways. Also, runoff moves as sheet-flows in many areas of the arctic tundra. This makes it difficult to predict meltwater drainages and culvert positions along roads. Even when culverts could be located appropriately, they still would be frozen by the time of spring melt; therefore, water impoundments are bound to occur in the upslope side of roads crossing drained thaw-lake basins. Changes in the hydrology of these sites also would cause a shift in plant-species composition, favoring the dominance of plant species adapted to wetter conditions such as *Carex aquatilis* and *Eriophorum angustifolium*. Moist or drier microsites such as polygon rims, hummocks, and strangmoor, often eliminated in flooded areas, generally are used as bird-nesting habitat (Walker et al., 1987).

Changes in plant-species composition also likely would occur in areas affected by thermokarst. Thermokarst (irregular depressions caused by melting and heaving of frozen ground) likely would occur where gravel roads and gravel pads cause changes in adjacent areas' moisture regime, natural drainage patterns, or snow-drift patterns (NRC, 2003b). Snow drifts caused by gravel structures increase wintertime soil-surface temperature and increase thaw depth in soils near the structures that, in turn, produce thermokarst and alter species composition of plant communities. Most changes in plant communities around gravels pads and gravel roads would occur within about 50 m of the structure. Warmed soils enhance nutrient availability leading to increases in annual primary production and a shift toward graminoids-dominated communities characterized by low plant species diversity.

Vegetation recovery would be extremely slow in gravel pads constructed in the open tundra, because their physical characteristics are completely different to the conditions required for the establishment of typical tundra and wetland plant species; therefore gravel-pad impacts, even when localized, may have a long-

lasting effect. Plant species sensitive to disturbance and with poor potential for recovery usually are common wetland species and include *Eriophorum vaginatum*, *Ledum palustre* spp. *decumbens*, *Vaccinium vitis-idaea*, *Dryas integrifolia*, *Betula nana*, *Arctostaphylos rubra*, *Salix phlebophylla*, and *S. reticulata* among others. Some mosses, particularly Sphagnum and *Tomentypnum nitens*, and all lichens also are very sensitive to disturbance with slow recovery rates. Direct physical effects on vegetation due to disturbances related to roads and gravel pads, as well as other impacts, can reduce the insulating quality of the vegetation and cause added disruption of the surface by thawing the underlying ice-rich permafrost (NRC, 2003b).

IV.C.1.j(4)(a)4 Introduction of Noxious Weeds. Permanent gravel roads likely would act as corridors for the migration and dispersal of non-native plants and noxious weeds into the Arctic. There is the potential to introduce non-native plants and noxious weeds with heavy equipment used in gravel borrow pits, pipelines, and so forth. Non-native plant species, however, may lack physiological and morphological adaptations required to survive extreme arctic conditions. Their growth and reproduction would be limited by extreme low temperatures in the soil and aboveground, short photoperiods, and sporadic midsummer freezings (NRC, 2003b).

IV.C.1.j(4)(a)5 Effects of Public Access to Isolated Vegetation Communities. A long-term indirect effect of roads is the access they provide to vast areas of undisturbed tundra vegetation, which increases the potential for impacts on otherwise isolated plant communities as a consequence of unstructured off-road traffic.

IV.C.1.j(4)(b) Discharges. Discharges include diesel, hydraulic fluids, and other fluids used in operating the shore-base facility and pump-station equipments. Vegetation recovery from diesel fuel spills would be slow. In experimental spills of crude oil and diesel fuel, tundra plant communities on diesel fuel plots showed no recovery after 1 year, with almost no recovery of mosses, lichens, and dicots (no graminoids).

IV.C.1.j(4)(c) Noise. Noise is expected not to have negative effects on plant communities.

IV.C.1.j(4)(d) Small Oil Spills. Potential for small oil spills would be expected from operation activities at the shore-base facility, pump stations, and onshore pipelines. Small oil spills originated on offshore pipelines and the hub platform also would be expected. Oil spills coming from offshore would have a low chance to reach shoreline estuaries and saltmarshes; therefore, their impact would be negligible. Small spills along the pipeline and from the shore-base facility would be expected not to spread over large areas, as the relatively flat coastal summer tundra has the capacity to store about 74,000-370,000 bbl of oil per square kilometer (USDOI, BLM and MMS, 1998). Small oil spills on snow-covered tundra would be constrained easily by the snow layer, and prompt cleanup efforts could minimize impacts on vegetation. If a valve breaks or oil is released with pressure, oil spills would be expected to cover larger areas. Should an oil spill occur during spring or summer, vegetation recovery would depend on the amount of oil accumulated at one location as well as the species composition of the plant community affected. Plant communities in dry areas would be particularly sensitive to oil spills, especially if sphagnum and *Dryas* are abundant. Studies on the effects of oil contamination of vegetation in the Prudhoe Bay region indicate that moderate concentrations (about 12 liters/m²) can result in the death of most plant species. Willows (*Salix spp.*), sedges (*Carex spp.*), cottongrasses (*Eriophorum spp.*), and a few aquatic mosses (e.g., *Scorpidium scorpioides*) seem to be more resistant to oil spills (Walker et al., 1987). Long-term recovery from light to moderate oil spill usually would be better, because the toxic components break down over time. Oil spilled on wet tundra likely would kill the moss layers and aboveground parts of vascular plants, including the macroflora present in the affected area.

IV.C.1.j(4)(e) Large Oil Spills (greater than or equal to 1,000 barrels). The OSRA estimates a 40% chance of one or more spills occurring. Impacts of large spills that saturate the soil with oil to a depth of more than 10 cm (4 in) have very slow recovery, and plant cover is still very poor after 12 years. Spills that saturate the tundra likely would be severe, and recovery would take 10 years or more.

If a large oil spill occurred offshore, the probabilities of such a spill reaching estuaries and saltmarshes along the Chukchi Sea would be very low. If the spill occurred close to the shoreline, the probability of adverse impacts on the estuaries and saltmarshes would depend on wind and wave conditions. However, when spills take place in open water, the potential for a quick response is higher. In situ booming and

skimming operations would be effective means to prevent oil spills from reaching sheltered bays where estuaries and saltmarshes typically are found. Due to the low tidal range typical in such environments, stranded oil would be subject to low rates of abrasion and dispersal by littoral processes. Oil deposition above the level of normal wave activity would occur, if the spill takes place during spring tides or during storm surges. In such case, oil stranded in emergent vegetation is expected to persist for long periods due to the low rates of dispersion and degradation. Impacts would include the destruction of emergent vegetation, if slick oil sinks into the root system (Owens, 1977).

IV.C.1.j(5) Effectiveness of Mitigation Measures. The following mitigation measures could be implemented on a site-specific basis when feasible so ensure that tundra vegetation and wetlands would be protected from direct impacts to the greatest extent practicable. The necessity for and effectiveness of the potential mitigation measures below would be dependant on the specific activities proposed and the particular location involved.

- Critical wetlands and sensitive areas would be identified, and construction of facilities would be avoided in such areas.
- Discharge of produced waters into open or ice-covered marine waters <10 m in depth is prohibited.
- Oil-spill-prevention and -control plans and contingency actions would be prepared to address prevention, detection, and cleanup of oil spills.
- Pipeline leak-detection systems would include the use of pigs (bullet-shaped devices that slide through pipelines to look for corrosion). Pig runs would be implemented systematically.
- Impacts would be minimized by restricting winter and summer off-road traffic, and road layout would be coordinated with standards.
- Gravel extraction would be conducted during winter. Transport and construction activities would be conducted using ice roads and ice pads.
- Overlaying material covering gravel borrow pits would be removed and set aside in overburden stockpiles. The organic-rich silt referred as “tundra sod” would be separated and stockpiled for later use in land rehabilitation.
- Gravel pits probably would be filled with water and shaped to provide appropriate depths along pond fringes to create the right conditions for emergent and aquatic vegetation growth (critical component in creating fish and waterfowl habitat).
- To prevent vegetation impacts related to thaw of the permafrost zone, gravel pads would be built over 1.8 m thick and, if needed, polyethylene insulation would be placed below the pads to reduce the amount of gravel necessary.
- Techniques to rehabilitate thick gravel pads likely would include reusing tundra sod by spreading it on gravel pads to improve productivity, sustain long-term plant growth, and allow for the establishment of a broad range of plant species.
- The creation of berms to capture drifting snow, modification of gravel pads’ hydrologic balance, and the addition of soils amendments would increase water retention and mulch to reduce evaporation (Jorgenson and Joyce, 1994).
- Gravel-pad restoration would include the use of nitrogen-fixing arctic native legumes (*Astragalus alpinus*, *Hedysarum alpinum*, *H. mackenzii*, *Oxytropis borealis*, *O. campestris*, etc) and other native species, as well as the use of sewage sludge.
- The removal of gravel pads and remediation of contaminated soils would be used when feasible.
- Bioremediation techniques would be used, if necessary, to accelerate vegetation recovery in areas affected by large spills.
- Mitigation measures for an offshore large spill would include the protection of sheltered saltmarshes and estuaries with booming and skimming operations, if climatic conditions permit (Owens et al., 1977).

IV.C.1.k. Economy.

All of the alternatives, except Alternative II - No Lease Sale, assume the same amount of oil and, for purposes of economic analysis, the levels of activity among alternatives and sale are very similar. Therefore, the economic effects to communities and to the State of Alaska are essentially the same.

A sale would generate economic activity manifested primarily in revenue to government, employment, and personal income. The economic effects would be in the North Slope Borough (NSB), Southcentral Alaska, Fairbanks, and the rest of the U.S. The exploration and development scenario in Section IV.A is the basis for analysis of potential economic effects in this section. The reader should refer to that section 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 NSB, 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.1.k(1) Revenues and Expenditures. Sale 193 would generate increases in NSB property taxes averaging about 25 % above the level of Borough revenues without the sales in the peak years (assumed to be \$180 million [see Sec. III.C.a(1)]) and taper off to <15% in the later years. The revenue to the NSB would be about \$46 million in the first year of production, tapering off to \$23 million in the later years.

The early years of production would generate increases in revenues to the State of Alaska of <0.3% above the level without the sale. The increases would taper off to an even smaller percentage in the latter years of production. The revenue to the State would be about \$25 million in the first year of production, tapering off to \$2 million in the later years.

The early years of production would generate increases in revenues to the Federal Government of <0.004% above the level without the sale. The increases would taper off to an even smaller percentage in the later years of production. The revenue to the Federal Government would be about \$700 million in the first year of production, tapering off to \$50 million in the later years.

These revenue forecasts are based in part on the Beaufort Sea final multiple-sale EIS (USDOJ, MMS, 2003a). That forecast is based on barrels of production. We took the ratio of revenue to barrels and applied it to the barrels forecast. The property tax mill rate in the NSB is 18.5. The State collects 20 mills and returns 18.5 mills to the NSB. The scenario for development in Section IV.A.2.c describes an overland pipeline from the landfall of the Chukchi Sea to the TAPS or nearer gathering point, for example in the NPR-A, up to 300 mi long. The State of Alaska has authority to tax oil- and gas-transportation pipelines (AS 43.52.060; Greely, 2007, pers. commun.). The pipeline and support facilities would be valued at approximately \$2.5 billion initially (Craig, 2007, pers. commun.). Over the years of production, the value of the pipeline is estimated to decline by 50%.

IV.C.1.k(1)(a) Employment and Personal Income (not related to oil spills). Sale 193 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. All direct OCS workers are assumed to work in enclaves on oil platforms on the OCS or onshore 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 NSB or in Southcentral Alaska or Fairbanks, as indicated in Table IV.C-1. 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 onshore along the Chukchi Sea or in the Prudhoe Bay area approximately half of the days in any year.

The forecast increase of total employment and personal income is shown in Table IV.C-1. The change is <2% over the 2003 baseline for the NSB and <0.5% over the 2005 baseline for 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-1, 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 193 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-1. The change for the rest of the U.S. would be <0.001% for all three phases of activity. The exploration and development scenario for Sale 193 indicates exploration activity would take place in 2006-2014, development activity in 2015-2019, and production in 2020-2045.

Sale 193 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.

“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 termed “personal income” in Table IV.C-1.

The direct workers residing in the NSB who are forecast in Table IV.C-1 represent <2% of the workers resident in Southcentral Alaska and Fairbanks. This is a slight increase from the early 1990’s total of about 1%. All of the Borough residents forecast are assumed to be Alaskan Natives. This is based on research in 1999 (Jack Faucett Assocs., Inc., 2000). We acknowledge that forecasting NSB Native residents working in OCS activities is particularly conditional given past history. See Section III.C.1 Economics for a further discussion of past history of NSB 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 NSB, the Borough will have additional revenues available that most will be used for its ongoing operations. This, in turn, results in NSB government jobs. In large part, this is how the indirect and induced jobs are generated in the NSB.

IV.C.1.k(1)(b) Employment Related to Large Oil Spills. Assuming a large oil spill of 1,500 bbl, we estimate employment to be 60 cleanup workers for 6 months in the first year, declining to zero by the third year following the spill. Assuming a large spill of 4,600 bbl, 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. The 60-190 workers make up about 0.6-1.9% of the workers who cleaned up the EVOS. For assumptions 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 EVOS of 1989. That spill was 240,000 bbl. 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 NSB 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 event of a 1,500- or 4,600-bbl 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-response 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. Also in the case of Sale 193, these spills could reach the shores of the Chukotka Peninsula of the Russian Federation.

If this were to occur, cleanup would be more complicated and require more labor and expense because of the international effort required. How much more effort would be related to this factor is difficult to estimate.

IV.C.1.k(1)(c) Trans-Alaska Pipeline. Sale 193 would produce 1 Bbbl of oil over 25 years of production. This oil would contribute to extending the useful life of the Trans-Alaska Pipeline.

IV.C.1.k(2) Stipulations and Information to Lessees. The standard stipulations and ITL clauses would not change the effects analyzed.

Subsistence as a Part of the North Slope Borough Economy. The predominately Inupiat residents of the NSB 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.1.l Subsistence-Harvest Patterns and IV.C.1.m Sociocultural Systems.

Conclusion. Sale 193 would generate increases in NSB property taxes that would average about 25% above the level of Borough revenues without the sales in the peak years and taper off to <15% in the later years. In the early years of production, the sale would generate increases in revenues to the State of Alaska of <0.3% above the same level without the sale. The increases would taper off to an even smaller percent in the later years of production. The change in total employment and personal income would be <2% over the 2003 baseline for the NSB and <0.5% over the 2005 baseline for the rest of Alaska for each of the three major phases of OCS activity. The employment and personal income increase includes workers to clean up assumed large oil spills of 1,500 bbl or 4,600 bbl. Sale 193 would contribute to extending the lifespan of the Trans-Alaska Pipeline.

IV.C.1.l. Subsistence-Harvest Patterns.

This section analyzes the effects of Alternative I (Proposed Action) for Sale 193 on subsistence-harvest patterns of communities near the proposed Chukchi Sea lease-sale area. This analysis discusses effects on subsistence-harvest patterns from large oil spills and noise and disturbance activities. Analytical descriptions of affected resources and species, in addition to indigenous Inupiat knowledge concerning effects, are described in each resource section in detail. Effects on certain communities outside of the lease-sale area are discussed in this analysis, because the OSRA model shows the potential for contact with coastal areas important to Kivalina and coastal communities along the Russian Chukchi sea shoreline. The model estimates a <0.5% chance of contact for the coastal areas south of Kivalina, Kotzebue, other Kotzebue Sound regional communities, Shishmaref, and Wales.

The Chukchi Sea Sale 193 area includes the portions of the marine subsistence-resource areas for Barrow, Wainwright, Point Lay, and Point Hope. Moreover, if economically recoverable amounts of oil are discovered, a support and processing shore-base facility, onshore pipelines, and roads associated with development could affect the terrestrial subsistence resources that are harvested by these coastal communities, as well as the inland community of Atkasuk.

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 the distribution of subsistence resources. These changes could occur as a result of 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; and oil spills. 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 Chukchi Sea Sale 193 area and on their subsistence-harvest practices.

Effects Definitions and Effects Levels. In evaluating the potential adverse effects from OCS activities, we look at the magnitude and duration of disruption. We use the five categories shown below, ranging from very low to very high, with "significant" effects equated to conditions described in the high category definition:

- **Very Low** – Subsistence resources could be periodically affected with no apparent effects on subsistence harvests.
- **Low** - Subsistence resources would be affected for a period of 1 year, but no resource would be unavailable, undesirable for use or greatly reduced in number.
- **Moderate** - One or more important subsistence resource would become unavailable, undesirable for use, or available only in greatly reduced numbers for a period not exceeding 1 year.
- **High** - One or more important subsistence resource would become unavailable, undesirable for use, or available only in greatly reduce numbers for a period of 1-2 years.
- **Very High** - One or more important subsistence resource would become unavailable, undesirable for use, or available only in greatly reduce numbers for a period of 2 or more years.

For subsistence resources, as the categories move from very low to very high, the timeframe of disruption increases (from periodic to 2 or more years), but the magnitude of the effect stays relatively constant (one or more important subsistence resource would become unavailable, undesirable, or available only in greatly reduced numbers). The categories have some overlap but have enough differences to allow the analyst to accurately describe the myriad potential effects into a single category.

In reporting the conclusion of our analysis of the potential adverse effects from OCS activities, we shift from this five-category scale to a single standard to provide a clear boundary that when crossed, signals significant effects. In part, the high category was selected to maintain continuity between our assessment of subsistence and sociocultural effects and the Environmental Justice significance threshold of disproportionately high adverse effects embedded in our assessment of human health and environmental effects of a proposed action on low income, minority populations under Executive Order 12898.

These thresholds were developed over time and reflect many years of comments and refinements to establish a reasonable threshold definition. We define the thresholds to be flexible so they can be applied to diverse resources of the different Alaska OCS Region planning areas. We carefully and rigorously apply these criteria to circumstances within each planning area.

The threshold for subsistence-harvest effects reflects what we have learned regarding the importance of the subsistence resources. Using the threshold, a significant effect occurs if a single important resource becomes unavailable or undesirable for use or available only in greatly reduce numbers for 1 year. Please note that the use of “or” instead of “and” means that any one of the three conditions individually will result in a significant effect. This approach results in a fairly broad threshold. For example, the significance threshold would be met if OCS oil and gas activities resulted in one important resource becoming undesirable for use for a period of 1 year, regardless of how available the resource was. In the Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003a), the analyses for Sales 186, 195, and 202 all used the lower threshold of 1 year (not 1-2 years) and interpreted this to mean unavailable, undesirable for use, or available only in greatly reduced numbers for one harvest season.

The absence of a significant effect does not equate to “no effect.” As shown in the five-category scale, and in the numerous analyses that we have undertaken, effects from activities can be adverse and noticeable before they reach the significance threshold. Furthermore, in the cumulative effects analysis, we analyze the combined effects of projected activities with other actions, because we know that effects that individually do not reach our significance threshold can exceed that significance threshold when considered collectively.

Subsistence-Harvest Patterns. To understand effects on subsistence-harvest patterns, it is important to recognize three major conditions for regional communities: (1) they rely heavily on sea mammals, particularly bowhead and beluga whales, walruses, and bearded seals, and fishes in the annual average harvest; (2) community subsistence-hunting ranges overlap for many species harvested; and (3) subsistence hunting and fishing are central cultural values in the Inupiat way of life.

The animals commonly hunted by Natives in Chukchi Sea coastal communities are bowhead and beluga whales; walruses; bearded, ringed, and spotted seals; polar bears; freshwater and marine fishes; caribou; waterfowl; and seabirds. The species hunted by each village depends mainly on proximity of harvestable

populations to each village and secondarily on harvest tradition (Becker, 1987; USDO, MMS, 1987c, 1990b, 1995a, 2003a, 2005b).

Subsistence land use and harvest patterns often are different among villages because of differences in access to game and fish, village size, and traditional patterns of use. For example, bowhead whales generally are accessible to hunters only at Point Hope, Wainwright, and Barrow; cliff-nesting seabirds and eggs are available only near Point Hope. Barrow, situated where the Chukchi and Beaufort seas meet, has access to resource bases from each planning area (Becker, 1987).

Because primary subsistence resources are migratory, the extent of potential impacts from OCS activities on subsistence hunting largely depends on the time of year that a specific activity occurs and the location. Subsistence activities are concentrated in time and space. Should activities be coincident in time and space such that subsistence animals are frightened away or hunter access to the animals is hindered, the subsistence-hunting effort may not provide the expected returns (Becker, 1987). For example, seismic-survey activities that coincide in time and space with the use of the lead system by these animals and subsistence hunters could have potential detrimental effects (Braund and Burnham, 1984). The Spring Lead System in the Chukchi Sea is the only dependable open water available in spring; it is vital to subsistence hunters who hunt bowhead and beluga whales in the leads and seals, walruses, and other marine mammals that inhabit the retreating ice. Because this area has been deferred from leasing and seismic surveys must have essentially ice-free conditions to operate, seismic activity in the lead system is not expected.

For more than 30 years, representatives of the NSB, the Alaska Eskimo Whaling Commission (AEWC), the Northwest Arctic Borough, local Tribal and city governments, and individual subsistence hunters have made their concerns clear about the potential impact of OCS exploration and development activity in the form of a list of community-specific issues: bowhead whales (effects related primarily to noise); interference with the spring hunt and the seaward displacement of the fall migration route. Hunters believe this noise-caused displacement has happened before and can happen again and that noise—especially that associated with seismic exploration—can push whales seaward by the time they get to Barrow (Becker, 1987; USDO, MMS, 1987c, 1990b, 1997, 2003a, 2004).

Eugene Brower testified in Barrow at the public teleconference for our draft EIS on the 1997-2012 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 USDO, MMS, 1996c).

IV.C.1.l(1) Effects from Routine Operations.

IV.C.1.l(1)(a) Effects from Discharges, Seismic Surveys, Noise, Disturbances, 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, seals, fish, caribou, and birds. Disturbance effects would be associated with aircraft and vessel noise, construction activities, and oil spills; specifically: (1) seismic surveys that occur before and after 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.

IV.C.1.l(1)(a)1) Effects from Discharges. For exploration wells, because of the high cost of synthetic drilling fluids now commonly used, it is assumed that 80% of the drilling mud will be reconditioned and reused. Only 20% (an estimated 95 tons) of “spent mud” per well will be discharged at the exploration site. All of the rock cuttings will be discharged at the exploration site. For production wells all waste products

(drilling mud, rock cuttings, and produced water) for on-platform wells will be treated and then disposed of in shallow wells on the production platform. For the surrounding subsea wells, drilling waste products could be barged to a coastal facility for treatment and disposal.

Drilling muds, cuttings, and other discharges are covered under the USEPA's NPDES General Permit for Oil and Gas Exploration (Permit No. AKG280000) for the Beaufort and Chukchi seas (see Sec.IV.C.1.a, Water Quality). The permit, using USEPA's Ocean Discharge Criteria, seeks to determine if activities will cause unreasonable degradation of the marine environment, specifically as they relates to (1) significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities, and (2) the threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms.

Effects from Discharges on Subsistence Resources. The NPDES General Permit concludes that impacts from exploratory oil drilling operations "based on the limited areal extent of impacts in relation to the total lease area containing prey, and the mobility of these species, impacts are judged to be minimal." For human health:

Overall, significant impacts to human health are not expected to result from the limited discharges of drilling mud that characterize the exploratory phase in the Arctic lease sales. The hazard associated with consuming fish and shellfish contaminated with metals or petroleum hydrocarbons is expected to be low. The reasons for this assessment are: bioconcentration factors for heavy metals other than methylmercury and for mobile aromatic hydrocarbons such as benzene are too low to warrant concern about biomagnification; mercury, which is potentially the most hazardous metal, is a relatively minor constituent of drilling muds; and the areas affected by exploratory drilling discharges are too small to contribute substantially to the diet of fish or shellfish harvested by fisheries. (USEPA, 2005)

Based on this assessment, effects from discharges on marine species such as bowhead whales, beluga whales, seals, walruses, marine fish, marine birds, and polar bears are not expected to contaminate these species, disrupt the harvest, or cause them to become unavailable to subsistence hunters.

IV.C.1.I(1)(a)2) Effects from Seismic Surveys. We assume that up to six surveys could be conducted during each open-water season. Seismic surveys in the Chukchi OCS probably will be coordinated with surveys in the Beaufort OCS to employ the same vessels. Typical 3D-survey operations will consist of a large seismic vessel that tows the airgun and receiving cable arrays and a smaller support boat. Survey times will average 20-30 days (with downtime) to cover a 200 mi² area.

The coastal environment of the Chukchi Sea contains important populations of whales, pinnipeds, fishes, and birds valued by subsistence hunters in the region. In the Chukchi Sea, pivotal habitats include the Chukchi polynya open-water lead system (important to migrating whales, other sea mammals, and birds); the shores and offshore waters of Capes Lisburne, Lewis, and Thompson (for seabirds); Ledyard Bay (for seabirds); Skull Cliff Kelp Beds (important marine habitat); Kasegaluk Lagoon (for nonsalmonid anadromous fish; birds, beluga whales, and spotted seals); Peard Bay (for birds, anadromous fish, spotted seals, and belugas); Kuk River Inlet (for anadromous fish); Pitmega River and Thetis Creek deltas (for birds); and Point Hope Spit (for migrating birds). Cape Lisburne is an important walrus haulout site—the only major haulout site on the eastern Chukchi coast (Braund and Burnham, 1984).

All of the aforementioned biological resources and resource areas could, to varying degrees, be impacted by geophysical seismic-exploration activities. Vessel movements and traffic (seismic vessel, support vessels, ice-management vessel, etc.) and high-energy sound sources generated by the seismic-airgun arrays could adversely affect the biological resources of the Chukchi Sea, including those that Alaskan Natives depend on for subsistence, if protective mitigation measures are not incorporated into seismic-operation plans.

Potential effects from seismic noise and associated vessel movements could affect whaling, sealing, bird hunting, and fishing in the open-water season. Access to subsistence resources, subsistence hunting, and the use of subsistence resources also could be affected by reductions in subsistence resources and changes in the distribution patterns of subsistence resources (USDOI, MMS, 1987c 2001b).

Effects from Seismic Surveys on Subsistence Resources.

Bowhead Whales. Bowhead whales can respond to noise and disturbance in a manner that would adversely affect the hunting of this species. Seismic surveys and associated vessels and helicopter traffic to and from the vessels have the potential to disturb these animals and displace them from normal migration patterns; such disturbance could disrupt the subsistence harvest. Generally, spring-lead whaling is done very quietly in man-powered skin boats. Gaining access to leads suitable for bowhead hunting dictates the success of whale hunters, and this access can be hindered by double leads, young ice, changing weather conditions, and fairly recent changes in ice thickness and extent brought on by changing climatic conditions in the Arctic (Braund and Burnham, 1984; USDOJ, MMS, 1987c).

If a seismic survey or support vessel were in the path of a whale chase, it could cause that particular harvest to be unsuccessful. Animals tend to avoid areas of high noise and disturbance and, thus, could become unavailable to a particular community or become more difficult to harvest. Short-term effects, such as flight behavior or increased wariness, also may make animals difficult to harvest. Noise and traffic disturbance from transiting seismic-survey vessels, survey-related supply vessels, and support icebreakers in or near the bowhead whaling area could cause bowhead whales to move into the broken-ice zone and offshore leads inaccessible to the Inupiat hunters or under the pack ice and become unavailable to hunters. This displacement could have a major impact on local access and harvest success of bowhead whales. In plentiful ice years, the length of the whaling season still might allow a successful hunt; in a year when poor weather and ice conditions shortened the whaling season, such an occurrence could cause the harvest to be reduced. Because seismic-survey activity generally is not begun until after July 1 and conflict avoidance measures are expected to be in place, such conflicts during the spring whaling season are not expected (Braund and Burnham, 1984; USDOJ, MMS, 1987c 1990b, 1995a, 2003a, 2005b).

Beluga Whales. Beluga whales are sensitive to noise and may be displaced from traditional harvest areas by heavy boat traffic or seismic survey noise. This disturbance response, even if brief, might temporarily interrupt the movements of belugas or temporarily displace some animals when the vessels pass through an area. Such events could interfere especially with beluga movements to and from the lagoon areas, particularly Kasegaluk Lagoon where Point Lay hunts belugas; this harvest is concentrated during a few weeks in early July. Reducing or delaying the use of these habitats by belugas could affect their availability to subsistence hunters. Additionally, there is evidence that belugas will accommodate or acclimate to a particular pattern of noise after extensive exposure, and such acclimation also could affect Inupiat hunter access. For example, Point Lay residents rely on the harvest of belugas more than any other Chukchi Sea village and, at the present time, they are very successful at herding these animals by boat into Kasegaluk Lagoon where they are then hunted. If noise from boat traffic and seismic-survey activity increased and the belugas acclimated to the noise, there is the possibility that this herding technique would be less successful and the hunt reduced (Braund and Burnham, 1984; USDOJ, MMS, 1987c 1995a, 1998; Huntington and Mymrin, 1996; Huntington, 1999; Mymrin, 1999).

In other coastal communities, belugas are harvested in the pack-ice leads in early summer. Because the beluga-hunting season for Wainwright and Point Hope takes place under two different conditions (in ice leads and in open water) and hunting is possible at different times over a 6-month period (late March-Sept.), noise and traffic disturbance would be expected to have lesser effects; however, repeated vessel passes close (within 1-4 km) to both hunters and cetaceans could disturb the whale hunt (USDOJ, MMS, 1987c 1990b, 1998, 2003a).

Seals. Effects of noise and disturbance on seals are likely to have less adverse subsistence-use effects than is the case with whales. Icebreakers briefly could disrupt some seal concentrations for up to a few days within a lead system, temporarily interrupt their movements, 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 significantly delay their migrations. Such traffic is not likely to have more than short-term effects on migrations or distributions; but the displacement of pinnipeds could affect the availability of these animals to subsistence hunters for that season. These short-term, localized effects on seals could negatively affect localized subsistence-hunting, but probably not affect overall annual harvest levels, and seals would not become unavailable during the year. Generally, the seal-harvest period is longer than for whales and allows residents to harvest seals during more times during the year (USDOJ, MMS, 1987c 1990b, 1995a, 1998, 2003a).

Walrus. Impacts to walrus subsistence-harvest activities are most likely to occur during summer when the animals migrate from the Bering Sea into the Chukchi Sea. Walrus hunting is concentrated in each community's subsistence-resource area during the open-water months, primarily from late May and early June through the end of August. Peard Bay is preferred by Barrow and Wainwright residents to harvest walrus. Helicopter traffic and seismic survey noise at this time could disturb walrus resting on ice pans, although it is not expected to affect walrus migration or distribution patterns. The common method use to hunt walrus is to approach the herds as they rest on ice pans in the broken-ice margin of the pack ice. If increased seismic-survey noise caused the dispersal of these herds, hunting success of local residents could be detrimentally affected. Noise and disturbance from seismic-survey boats and other vessels could be a problem, if boat traffic moved near marine mammal-haulout areas. Because seismic-survey activities are unlikely to occur until after July 1 and must avoid areas with ice concentrations, conflicts with the subsistence walrus hunt are not expected (USDOJ, MMS 1987c 1990a, 1995a, 1998, 2003a).

Birds. The impacts of noise and disturbance in offshore areas on waterfowl could disturb waterfowl-feeding and nesting activities, but effects are expected to be periodic and short term and not to have significant effects on bird harvesting by coastal subsistence communities. Seismic-survey activities are not anticipated to occur in nearshore waters where many marine birds are found and where subsistence harvesting occurs. Seismic-survey vessels would remain at least 17 km (10 mi) offshore, so they would not come close to bird-nesting areas. It is more likely that vessels might disturb marine and coastal birds that are foraging, resting or molting at sea (Braund and Burnham, 1984; USDOJ, MMS, 1987c 1990b, 1995a, 1998).

Fishes. The impacts of noise and disturbance in offshore areas on fish harvests likely would be minimal, although the increased noise potential of four concurrent seismic surveys (especially ocean-bottom-cable surveys in shallower waters nearshore) could displace and disturb fish migrations and distributions and potentially "herd" them away from traditional subsistence-fishing areas (see Sec. IV.C.1.d, Fish Resources; Braund and Burnham, 1984; USDOJ, MMS, 1987c 1990b, 1995a).

Polar Bears. Active seismic-survey activities are likely to result in startle responses by polar bears near the sound source. As with other vessel traffic, this disturbance response is likely to be brief, and affected animals are likely to return to normal behavior patterns within a short period of time after seismic vessels have left the area. Polar bears could experience short-term, localized aircraft-noise disturbance—effects that would cause some disruption in their harvest—but this is not expected to affect annual harvest levels. Icebreaker noise would result in only short-term, local displacement on polar bear migrations and distributions, but such displacement could affect the availability of polar bears to subsistence hunters for that season. Because seismic-survey activities would be not planned until after July 1 and would avoid areas of high ice concentration, conflicts with the subsistence polar bear hunt are not expected (USDOJ, MMS 1987c 1998, 2003a).

IV.C.1.l(1)(a)3 Effects from Other Noise and Disturbance. Marine mammals are sensitive to noise disturbance, although thresholds in terms of signal characteristics and distance for each species have not been established. Generally, such effects would be localized to the vicinity of the construction site, the drilling/production unit, and to the actual time of operation. Lease stipulations for whaler/oil industry conflict resolution and other "nondisturbance" agreements have minimized such problems in the recent past, so that noise and disturbance effects of single actions have been largely effectively mitigated (USDOJ, MMS, 2001b).

Past industry activities have been effectively limited in specified areas during critical periods of subsistence use through industry/subsistence user cooperation. The potential disturbance effects of production operations may be more difficult to mitigate as such activities will, by definition, be longer term and operate year-round. With potential exploration and development activities in the Chukchi Sea and the potential from Sale 193 of up to 6 exploration wells, 8 delineation wells, 1 production platform, up to 120 production wells, and 40 service wells, as well as the construction of 50 mi of in-field flow lines, 150 mi of offshore pipeline, up to 300 mi of onshore pipeline to connect to the Trans-Alaska Pipeline System (TAPS), and an onshore support and processing facility (e.g., at Peard Bay), noise and disturbance increases in the areas where subsistence activities occur are expected. This would increase the possibility

for significant harvest disruption. Noise and traffic disturbance would be a factor throughout the life of the sale (USDOJ, MMS, 2001b).

Aircraft and Vessel Support. Noise and disturbance effects would occur from aircraft and vessel support for exploration and development activities. Air support would include helicopter flights to seismic vessels (1 per day), helicopter flights for exploration drilling (1-3 per day), aircraft flights for shore-base construction support (5, C-130 aircraft per day dropping to smaller aircraft and 2 per day), helicopter flights for offshore construction (1-3 per day), and helicopter flights for production (1-3 per day). Vessel support and supply would include support-vessel traffic for seismic boats for refueling and resupply (1 every 2 weeks; icebreaker-support traffic would be a factor as well), support-vessel traffic for exploration drilling (1-3 trips per week), support-vessel traffic for shore-base construction (1-2 barge trips per season), support-vessel traffic for production (1 trip every 2 weeks), and disposal barge trips (2 trips per season).

Drilling. Noise and disturbance effects would occur from drilling activities during the exploration, development, and production phases, which include the drilling of 6 exploration and 8 delineation wells, up to 120 production wells, and 40 service wells. Any drilling activity is expected to be outside of the polynya and spring-lead deferral area.

Construction. Noise and disturbance effects would occur from the installation of 1 production platform offshore, on- and offshore pipeline construction (up to 50 mi of in-field flow lines, 150 mi of offshore pipeline, and 300 mi of onshore pipeline to connect to TAPS), as well as the construction of a landfall and an onshore support and processing facility (e.g., at Peard Bay).

Offshore pipeline effects on subsistence would be confined to the period of construction and, to some extent, would be mitigated through lease stipulations designed to minimize industry activities during critical subsistence-use periods.

The main period for onshore pipeline effects on subsistence would occur during the 1- or 2-year construction period, but certain effects would continue for the operational life of the pipeline. The major onshore pipeline constructed for the Proposed Action would connect Chukchi Sea oil production with the TAPS. It would cross a large area that is currently undeveloped, except for isolated and relatively small airstrips in various conditions. Some potential effects of the pipeline on subsistence resources and practices would be unavoidable but could be at least partially mitigated and minimized with proper pipeline design and routing. Some potential effects of a pipeline on subsistence users (avoidance of traditional areas, more difficult access to traditional areas) can be addressed with design considerations (by elevating or burying segments of the pipeline) and by including subsistence users in the consultation process (USDOJ, MMS, 2001b).

The most difficult potential onshore pipeline effects to mitigate would be those related to pipeline servicing and access. If a service road is constructed for this purpose, it would greatly increase access to subsistence resources on the western part of the North Slope. This effect would be greater if such a road eventually were opened to public access, on the model of the Dalton Highway. Roads also are reported to impose substantial maintenance costs on subsistence equipment (snowmachines and sleds) and to present some safety issues (Impact Assessment, Inc., 1990a). Current practices are to minimize the construction of new roads. If pipeline servicing was conducted using aircraft and ice roads or other ground transport in winter, such potential access effects would be minimized. Increased aircraft traffic in the summer could have effects on subsistence practices but, with coordination with subsistence users, these effects could be reduced (USDOJ, MMS, 2001b).

IV.D.1.1(1)(a)4 Effects from Other Noise and Disturbance on Subsistence Resources.

Aircraft and Vessel Support.

Bowhead Whales. Bowhead whales, if their migration up the Chukchi Sea coast in the spring were coincident with air, vessel, and barge traffic could be disturbed by these activities. Whales could react to non-seismic-survey-related icebreaking noise at distances ranging from 2-25 km. If air and vessel traffic is coordinated through Conflict Avoidance Agreements (CAA's) to avoid interfering with the migration, overall effects from noise-producing activities on bowhead whales most likely would be temporary and

nonlethal. Noise and disturbance from aircraft and vessel traffic would have localized, short-term effects that would cause some disruption to the harvest but would not cause bowheads to become unavailable to subsistence hunters.

An increase in exploration, development, and production results in a greatly increased amount of marine vessel activity including icebreakers, barges, sealifts, seismic vessels, supply boats, crew boats, and tugs. Whales respond strongly to vessels directly approaching them. Avoidance of a vessel usually begins when a rapidly approaching vessel is 1-4 km away, with a few whales possibly reacting at distances from 5-7 km. Received noise levels as low as 84 dB re 1 μ Pa, or 6 dB above ambient, may elicit strong avoidance of an approaching vessel at a distance of 4 km. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period.

Icebreaker-response distances vary. Predictions from models indicate that bowhead whales likely would respond to the sound of the attending icebreakers at distances of 2-25 km, with roughly half of the bowhead whales showing avoidance response to an icebreaker underway in open water at a range of 2-12 km when the sound-to-noise ratio is 30 dB, and roughly half of the bowhead whales showing avoidance response to an icebreaker pushing ice at a range of 4.6-20 km when the sound-to-noise ratio is 30 dB. Whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources.

An increase in exploration, development, and production also results in greatly increased aircraft traffic. Most bowheads exhibit no obvious response to helicopter overflights at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some bowheads probably would dive quickly in response to the aircraft noise. Bowheads are not affected much by any aircraft overflights at altitudes above 300 m (984 ft). Below this altitude, some changes in whale behavior might occur, depending on the type of plane and the responsiveness of the whales present in the vicinity of the aircraft. Fixed-wing aircraft flying at low altitude often cause hasty dives. Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). 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. However, given the extremely high number of helicopter flights documented to support Northstar, bowheads may be repeatedly exposed to helicopter noise in areas between shore bases and/or airports and the production facilities. Depending on where shore bases, exploration activities, and production facilities are located, the effect of such interruptions could result in repeated interruption and increased stress to whales in the flight path. This could become biologically important if the whales in the area were feeding, resting, or nursing. This potential effect could be mitigated by ensuring that flight paths avoid whale aggregations or that flights are high enough to avoid disturbance.

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. There is variability in their response to certain noise sources. Some of the variability appears to be context specific (i.e., feeding versus migrating whales) and also may be related to reproductive status and/or sex or age (see Sec. IV.C.1.f(1), Threatened and Endangered Marine Mammals; USDO, MMS, 1987c 1990b, 1998, 2003a; USDO, BLM, 2005). We expect that deferred areas and CAA's will keep aircraft and vessel traffic from conflicting with critical bowhead harvest areas and seasons.

Beluga Whales. Some potential noise and disturbance from aircraft traffic could occur along the coast. The primary source of noise and disturbance would come from air traffic along the coast of the Planning Area, specifically from helicopters and other aircraft associated with the projected oil-exploration and -development activities. Even a brief disturbance response from aircraft and vessel noise might temporarily interrupt the movements of belugas or temporarily displace some animals when vessels pass through an area. Such events could interfere especially with beluga movements to and from the lagoon areas, particularly Kasegaluk Lagoon where the community of Point Lay hunts belugas; this harvest is concentrated during a few weeks in early July. Reducing or delaying the use of these habitats by belugas could affect their availability to subsistence hunters.

Additionally, there is evidence that belugas will accommodate or acclimate to a particular pattern of noise after extensive exposure, and such acclimation also could affect Inupiat hunter access. For example, Point

Lay residents rely on the harvest of belugas more than any other Chukchi Sea village and, at the present time, they are very successful at herding these animals by boat into Kasegaluk Lagoon where they are then hunted. If noise from boat-traffic activity increased and the belugas acclimated to the noise, there is the possibility that this herding technique would be less successful and the hunt reduced. Nevertheless, we expect that deferred areas and CAA's will keep aircraft and vessel traffic from conflicting with critical beluga harvest seasons.

Belugas generally do not get close enough to icebreakers for potentially harmful effects to occur. However, if the animals are engaged in important behavior such as mating, nursing, or feeding, they might not flee and might tolerate louder noises. Problems can arise in heavily industrialized areas where a variety of noisy activities take place. Cumulative noise levels could be very high for long periods of time and cover such large areas that animals might be either permanently displaced or adversely affected, because they have nowhere to flee to (Erbe and Farmer, 2000). Overall, noise and disturbance from aircraft and vessel traffic would have localized, short-term effects that could cause some disruption to the harvest but would not cause belugas to become unavailable to subsistence hunters (see Sec. IV.C.1.h., Other Marine Mammals; Braund and Burnham, 1984; USDO, MMS, 1987c 1995a, 1998; USDO, BLM, 2005).

Seals. Aircraft traffic (particularly helicopter trips) and supply-boat traffic is assumed to be a potential source of disturbance to bearded, ringed, and spotted seals hauled out on the ice or beaches along the coast. Air-traffic disturbance would be very brief and would disturb small groups of seals hauled out along the coast. The effects of air traffic on pinnipeds in the action area are expected to be local and transient in nature. Some groups of pinnipeds may be disturbed from their haulouts and enter the water, although their responses will be highly variable and brief in nature. Mitigation measures prohibiting aircraft overflights of hauled out walrus below 1,000 ft will lessen aircraft impacts to these pinnipeds (see Sec. IV.C.1.h., Other Marine Mammals; Braund and Burnham, 1984; USDO, MMS, 1987c 1995a, 1998; USDO, BLM, 2005).

Icebreakers briefly could disrupt some seal concentrations for up to a few days within a lead system, temporarily interrupt their movements, 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 significantly delay their migrations. Noise and disturbance from aircraft and vessel traffic would have localized, short-term effects that would cause some disruption to the harvest but would not cause seals to become unavailable to subsistence hunters (see Sec. IV.C.1.h., Other Marine Mammals; Braund and Burnham, 1984; USDO, MMS, 1987c 1995a, 1998; USDO, BLM, 2005).

Walrus. Oil and gas activities that occur during ice-minimum conditions in summer in the Chukchi Sea are likely to come into direct contact with adult females and subadult walrus (Jay et al., 1996). If disturbance causes walrus to abandon preferred feeding areas or interferes with calf-rearing, resting, or other activities, then the walrus population could be negatively affected. Walrus will flee haulout locations in response to disturbance from aircraft and ship traffic, although reactions are highly variable (Richardson et al., 1995a). Females with dependent young are considered the least tolerant of disturbances. Helicopters are more likely to elicit responses than fixed-wing aircraft, and walrus are particularly sensitive to changes in engine noise and are more likely to stampede when aircraft turn or bank overhead. Researchers conducting aerial surveys for walrus in sea ice habitats have reported little reaction to aircraft above 1,000 ft (305 m). Brueggeman et al. (1991) reported that 81% of walrus encountered by vessels in the Chukchi Sea exhibited no reaction to ship activities within less than a kilometer, which suggests that walrus may be tolerant of ship activities and movements. However, ice-management operations are expected to have the greatest potential for disturbances to walrus. For example, Brueggeman et al. (1991) reported that walrus moved 20-25 km from active icebreaking operations, where noise levels were near ambient. Conversely, researchers onboard an icebreaker during ice-management operations observed little or no reaction of hauled out walrus groups beyond 0.5 mi (805 m) of the vessel (Garlich-Miller, 2006, pers. commun.). Overall, noise and disturbance from vessel and aircraft is expected to have localized, short-term effects that could cause some disruption to the walrus harvest but would not cause walrus to become unavailable to subsistence hunters (see Sec. IV.C.1.h., Other Marine Mammals; Braund and Burnham, 1984; USDO, MMS, 1987c 1995a, 1998; USDO, BLM, 2005).

Caribou and Other Terrestrial Mammals. With increased activity from development, aircraft traffic more often would pass overhead of caribou and other terrestrial mammals (muskoen, grizzly bears, and arctic

foxes) during flights to and from onshore construction areas and along aerial-survey routes, with a greater number of individual animals being exposed to human activities. The effects of Chukchi Sea oil exploration and development on caribou, muskoxen, and grizzly bears would likely include local displacement within about 4 km of onshore pipelines and roads. Localized, short-term effects would cause some disruption to the harvest but would not cause caribou and other terrestrial mammals to become unavailable to subsistence hunters (see Sec. IV.C.1.i, Terrestrial Mammals; Braund and Burnham, 1984; USDO, MMS, 1987c 1995a, 1998; USDO, BLM, 2005).

Birds. The noise and presence of aircraft operating at low altitudes have the potential to disturb birds. Birds would flush or move away from the noise and approaching aircraft. There is an energetic cost to repeatedly moving away from aircraft disturbances as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability. Aircraft- and vessel-noise disturbance could displace birds from the local areas where disturbance events are occurring. Little direct mortality is expected, but losses of eggs and young to predators when adults are displaced is likely to occur. Disturbed adults routinely 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 all sources of disturbance and habitat alteration is expected to occur within a few generations. Localized, short-term effects would cause some disruption to the subsistence harvest of birds but would not cause them to become unavailable to subsistence hunters (see Sec. IV.C.1.g, Marine and Coastal Birds; Braund and Burnham, 1984; USDO, MMS, 1987c 1995a, 1998; USDO, BLM, 2005).

Polar Bears. Vessel traffic associated with exploration and development activity is not expected to cause impacts to polar bears, because they show little reaction to vessels and generally do not linger in open water. Brueggeman et al. (1991) observed polar bears in the Chukchi Sea during oil and gas activities and recorded their response to an icebreaker. While bears did respond (walking toward, stopping and watching, walking/swimming away) to the vessel, their responses were brief. Localized, short-term effects would cause some disruption to the subsistence harvest but would not cause polar bears to become unavailable to subsistence hunters (see Sec. IV.C.1.h., Other Marine Mammals; Braund and Burnham, 1984; USDO, MMS, 1987c 1995a, 1998; USDO, BLM, 2005).

Drilling.

Bowhead Whales. Bowheads respond to drilling noise at different distances depending on the types of platform from which the drilling is occurring. Data indicate that many whales can be expected to avoid an active drillship at 10-20 km or possibly more. The response of bowhead whales to construction in high-use areas is unknown and is expected to vary with the site and the type of facility being constructed. Similarly, the long-term response of bowheads to production facilities other than gravel islands located at the southern end of the migration corridor is unknown (see Sec. IV.C.1.f(1), Threatened and Endangered Marine Mammals; USDO, MMS, 1987c 1990b, 1998, 2003a, 2006a; USDO, BLM, 2005; Richardson et al., 1995a; Davis, 1987).

Seals, Walruses, Birds, and Polar Bears. The relatively constant, low-frequency noise coming from drilling platforms would be considered a secondary disturbance source to these species and is not expected to disturb them as much as noise from aircraft and vessel traffic. For birds, the presence of a single drill ship and its support vessels operating in a small area and the risk of disturbance from vessel presence and activity could be considered low from the drill ship, but disturbance from support vessels and aircraft traveling to shore could be extensive due to the long distances traveled. By operating support vessels along predesignated routes and aircraft along predesignated routes and altitudes, the risk of disturbance from aircraft could be mitigated. For seals, effects are expected to be short term, and localized, with no consequences to the seal populations as a whole (see Secs. IV.C.1.h, Other Marine Mammals and IV.C.1.g, Marine and Coastal Birds; USDO, MMS, 1987c 1990b, 1998, 2003a, 2004, 2006a,d; USDO, BLM, 2005).

Construction Effects on Subsistence Use. Industrialization displaces subsistence users from traditional use areas even if no legal impediments to access are imposed (NSB, 2003). If development were to occur in areas containing concentrations of subsistence or traditional-use sites and subsistence resources experienced only minor impacts, subsistence users would be displaced and impacts would be expected to be greater (USDO, MMS, 1987c 1990b, 1998, 2001b, 2003a, 2004, 2006a,d; USDO, BLM, 2004, 2005).

Onshore and offshore construction would affect local availability of key subsistence such as bowhead and beluga whales, seals, walruses, caribou, waterfowl, fish, bears, wolves, and other furbearers because of displacement. Subsistence access would be affected as subsistence users avoid construction areas because of perceived regulatory barriers and safety concerns about shooting around development sites. Subsistence hunters consequently would travel farther, at greater costs and effort. Generally, affected areas are used for multiple resources, key resources are harvested during more than one season, and these resources have been used for multiple generations. Effects from construction could occur in key geographic areas relative to other areas of subsistence availability and would tend to impact individual subsistence users, groups of users, and overall patterns of subsistence uses (USDOJ, MMS, 1987c 1990b, 1998, 2001b, 2003a, 2004, 2006a,d; USDOJ, BLM, 2004, 2005).

Onshore oil-development impacts on the subsistence-harvest system similar to those observed from development at Prudhoe Bay could be expected. Additionally, there are more general indirect effects that result from increased wage employment made available through projects and services funded by the NSB. 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 NSB 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) 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. Chukchi Sea communities potentially could be subjected to similar development pressures.

Bowhead Whales. Construction of bottom-founded platforms likely would be conducted during the open-water season. Noise, disturbance, and habitat alterations from platform installation, pipeline laying, and other construction could have some adverse effects on bowhead whales. These activities could affect bowhead whales if they are conducted during the whale migration. 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. Intense noise causes startle, annoyance, and flight responses in whales, and some whales could be displaced seaward by construction and noise disturbance. Traditional Inupiat observation and experience affirms that whales are affected by noise at greater distances and alter their swimming directions for longer periods. Effects on bowhead whales from construction activities most likely would be temporary, nonlethal effects. There is variability in their response to certain noise sources. Some of the variability appears to be context specific (i.e., feeding versus migrating whales) and also may be related to reproductive status and/or sex or age (see Sec. IV.C.1.f(1), Threatened and Endangered Marine Mammals; USDOJ, MMS, 1987c 1990b, 1998, 2003a,b,d; USDOJ, BLM, 2005).

Beluga Whales. Noise and disturbance and habitat alterations from platform installation, pipeline laying, and other construction could have some adverse effects on beluga whales found in the proposed 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 in beluga whales. The installation of one production platform and the laying of 150 mi of offshore pipelines and the disturbance of benthic habitat likely would have a short-term and local effect on these marine mammals (see Sec. IV.C.1. h, Other Marine Mammals; USDOJ, MMS, 1987c, 1990b, 1998, 2003a, 2006a; USDOJ, BLM, 2005).

Seals. Noise and disturbance and habitat alterations from platform installation, pipeline laying, and other construction would have a short-term and local effect on these marine mammals (see Sec. IV.C.1.h, Other Marine Mammals; USDOJ, MMS, 1987c, 1990b, 1998, 2003a,b,d; USDOJ, BLM, 2005).

Walruses. Noise, disturbance, and habitat alterations from platform installation, pipeline laying, and other construction would have a short-term and local effect on walruses. The installation of one production platform and the laying of 150 mi of offshore pipelines would disturb benthic habitat along the pipeline route. Construction activities for the processing and support facility in the vicinity of Peard Bay, a walrus harvest area preferred by Barrow and Wainwright residents, would elevate disturbance effects on walruses.

Construction of an onshore facility elsewhere would have disturbance effects on resources specific to that locality (see Sec. IV.C.1. h, Other Marine Mammals; USDO, MMS, 1987c, 1990b, 1998, 2003a,b,d; USDO, BLM, 2004, 2005).

Caribou and Other Terrestrial Mammals. During development, onshore construction noise, lights, and traffic, would divert and displace caribou and furbearers, resulting in decreased availability of these resources to hunters near these locations. Disturbance to caribou, moose, muskoxen, grizzly bears, wolves, wolverines, arctic foxes, and small mammals would occur for the duration of construction of onshore pipelines to the TAPS and would be most intense during the construction period when ice-road traffic is highest, but would subside after construction is complete. After construction, effects would become more short term and local, except for caribou, which would have to adjust to potential seasonal ice-road traffic and crossing a new onshore pipeline and accompanying vehicle traffic associated with the pipeline. Generally, 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, but expected effects would be local displacement within about 1-2 km (0.62-1.2 mi) along pipelines.

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. Specifically, onshore facilities and activities associated with proposed offshore development would have temporary impacts on individual caribou but negligible effects on caribou herds. However, at the local level, where hunters have customary hunting areas, minor shifts in caribou availability can have a notable affect on subsistence access to caribou. Caribou could become unavailable where hunters normally harvest them in the numbers and conditions that hunters normally would anticipate without the disturbances of industrial activities (see Sec. IV.C.1.i, Terrestrial Mammals; USDO, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004, 2006b,d; USDO, BLM, 2004, 2005).

Negative impacts to caribou and subsistence hunting can continue to be minimized by mitigation measures, including: (1) construction of pipelines at least 100 m from roads; (2) elevation of the pipelines at least 7 ft above the ground; (3) continued traffic control in critical areas such as calving grounds in season; (4) buried or higher elevation pipelines in areas that are typically traveled heavily by caribou; and (5) adherence to minimum altitude levels for aircraft in flight (USDO, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2006b,d; USDO, BLM, 2004, 2005).

Birds. Any construction activities that take place in summer could temporarily displace birds using areas near such sites for one season or less. This local disturbance of birds within about 1 km of construction activities would be short term, and is not likely to cause significant population effects. Localized burial of potential prey and destruction of a few square kilometers of foraging habitat as a result of pipeline trenching is not likely to cause a significant decline in prey availability (see Sec. IV.C.1.g, Marine and Coastal Birds; USDO, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004, 2006b,d; USDO, BLM, 2004, 2005).

A significant number of ducks and geese spend the summer near the Red Dog Mine port site, with both breeding and nonbreeding birds remaining in the port site vicinity all summer. These birds become habituated to shipping activity at the port site and spend the summer nesting or living nearby without apparent harm. In spring 2000, U.S Army Corps of Engineers biologists saw subsistence hunters killing geese in the North Port Lagoon and shooting at geese in the South Port Lagoon during marine mammal surveys from the port site barge-loader observation platform (U.S. Army Corps of Engineers, 2005).

Maximum disturbance of birds is likely to occur in the general vicinity of Peard Bay, because most development probably would focus on this area and the construction of a pipeline between a production platform and an onshore base could cross many important bird habitats. Depending on the construction season, the construction of a pipeline could displace and/or disturb marine and coastal birds in a variety of pelagic, nearshore, estuarine, and terrestrial habitats. Many of these disturbing activities could have fewer impacts to many birds if they were to occur during the winter, when most birds are not present. Due to the uncertainty of routes, specific conservation measures to avoid or minimize disturbance from activities associated with onshore bases and pipelines are not included in the Proposed Action and disturbances associated with oil production would be further evaluated in future NEPA documents. Onshore, because

nesting sites are scattered at low density on the Arctic Coastal Plain, relatively few are likely to become unavailable through pipeline 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, vehicle-traffic disturbance, or helicopter traffic for pipeline inspections. Routine disturbance effects would persist over the life of the field and would be localized primarily within about a kilometer of the pipeline. The availability of shorebird insect prey is likely to be adversely affected near roads, and some shorebird-nesting attempts would be displaced. Overall, minor adverse effects would be anticipated (see Sec. IV.C.1.g, Marine and Coastal Birds; USDO, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004, 2006b,d; USDO, BLM, 2004, 2005).

Fishes. Noise, habitat changes, and discharges from drilling operations, dredging, pipeline trenching, gravel mining, and abandonment can have a measurable effect on fish populations. The nature of these impacts primarily are short- and long-term displacement from work areas due to emitted underwater sounds and sediment plumes, short-term losses of seafloor habitats and individual organisms during platform and pipeline construction (excavation/smothering), and multiyear injury/mortality in a “zone-of-influence” (as measured by radii thousands of meters long) from piles of discharged well-drilling fluids around exploratory well drilling sites. While some fish could be harmed or killed, most in the immediate area would avoid these activities and otherwise would be unaffected (see Sec. IV.C.1.d, Fish Resources; USDO, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004, 2006b,d; USDO, BLM, 2004, 2005).

Polar Bears. Noise and disturbance from platform installation, pipeline laying, and other construction could have some adverse effects on polar bears 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 polar bears. If offshore ice-road construction occurred, it might alter some ice habitats and displace some denning polar bears. Land-based industrial activities and human presence near polar bear dens pose potentially serious disturbances. However, some denning polar bears are known to have tolerated ice road traffic that was 400 m away (see Sec. IV.C.1.h, Other Marine Mammals; Amstrup, 1993; USDO, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004, 2006b,d; USDO, BLM, 2004, 2005).

Experience with captive female polar bears suggests that these bears can be especially sensitive to noise and human presence during maternity denning. Human scent and noises near maternity dens also may disturb the bears. 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).

During construction activities associated with Chukchi Sea development, a small number of polar bears located within a few kilometers of the landfall and processing site could be disturbed and 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 and processing site (USDO, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004, 2006b,d; USDO, BLM, 2004, 2005).

It is possible that some polar bears could be unavoidably killed to protect oil workers, when the bears were attracted to drilling rigs due to food odors and curiosity. Under the MMPA, oil companies are required to have a permit to take or harass polar bears. Consultation between the companies and the FWS on this matter is expected to result in the use of nonlethal means in most cases to protect the workers from polar bear encounters. Construction impacts on polar bears are expected to be short-term and local (see Sec. IV.C.1. h, Other Marine Mammals; USDO, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004, 2006b,d, 2006; USDO, BLM, 2004, 2005).

IV.C.1.1(a)5 Effects from Small Oil Spills. Small spills, although accidental, generally are routine and expected. The causes of onshore crude oil spills are leaks, faulty valves/gauges, vent discharges, faulty connections, ruptured lines, seal failures, human error, and explosions. The cause of approximately 30% of the spills is unknown. Most small spills that occur are contained and do not reach the environment (ADEC, 2001). For spills <500 bbl, the estimated number and volume of small crude oil spills is 178 spills of 3 bbl for the Proposed Action: for spills between 500 and 1,000 bbl, the estimated number and volume of spills is 1 of 680 bbl for the Proposed Action. For refined fuel spills (aviation fuel, diesel fuel, engine lube, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil), the EIS scenario assumes an average refined-spill size of 0.7 bbl, with 440 such spills estimated for the Proposal.

Over the production life of the Chukchi Sea Sale 193, small spills would occur offshore on drilling structures and onshore on gravel pads near pipeline tie-in locations. Because of the small size of these spills and their expected containment onsite, effects on subsistence resources likely would be negligible, although this would depend on the context of the spill, the area covered by spilled product, and the amount of time the product was in the environment before cleanup efforts began. Oil spills in winter on snow or frozen tundra typically would be contained and cleaned up relatively quickly; spills in summer that were not contained would be quite difficult to clean up and would have lingering impacts on the impacted tundra, regardless of the area covered. It might be impossible to completely clean up spills that reached or occurred in waterways, in open water, or broken ice. Offshore spills should have minimal effects on marine mammals, as onshore spills should have minimal effects on terrestrial mammals. Accidental small oil spills periodically could affect subsistence resources (USDOI BLM and MMS, 2003, USDOI, BLM, 2004, 2005, 2006; USDOI, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004, 2006b,d).

Effects from Small Oil Spills on Subsistence Resources.

Bowhead and Beluga Whales and other Marine Mammals. Small offshore oil spills should have minimal effects on marine mammals because of their expected containment onsite, minimal contact with habitat, and, their brief persistence in the environment due to their size and to environmental weathering. There could potentially be displacement of bowhead whales from a local feeding area following a fuel spill, and this displacement could last as long as there is a large amount of oil and related cleanup-vessel activity. Individual bowhead whales potentially could be exposed to spilled fuel oil, and this exposure could have short-term effects on health. Outside of a major fuel spill resulting from a vessel sinking, we expect seismic-survey spill-related effects to be minor. For beluga whales, if a small oil/fuel spill were to occur, it would be easily avoidable by them; impacts, if any, most likely would include temporary displacement until cleanup activities are completed and short-term effects on health from the ingestion of contaminated prey. The spill event described by Barrow elder Thomas Brower, Sr., caused by a U.S. Navy vessel in the Plover Islands east of Barrow in 1944 caused whales to make a “wide detour out to sea from these islands” for 4 years. The whale hunt was curtailed for that time at that location.” Also, he observed “how seals and birds who swam in the water would be blinded and suffocated by contact with the oil.” This spill event reveals that species can experience recovery from an oil spill in the Arctic after 4 years without cleanup, although the event is still 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 (see Secs. IV.C.1.f(1), Threatened and Endangered Marine Mammals and IV.C.1.h, Other Marine Mammals; Brower, as cited in North Slope Borough, Commission on History and Culture, 1980).

Caribou and Other Terrestrial Mammals. Small 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, because they are selective grazers and particular about the plants they consume, caribou and muskoxen probably would not ingest oiled vegetation (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 would frighten caribou, muskoxen, grizzly bears, and arctic foxes away from the spill and prevent them from grazing on the oiled vegetation. Small spills would tend to be localized although contamination effects could last several years; however, they are not likely to directly affect caribou, muskoxen, or other terrestrial mammals through ingestion of oiled vegetation. The extent of environmental impacts would depend upon the type and amount of materials spilled, the location of the spill, and effectiveness of the response (see Sec. IV.C.1.i, Terrestrial Mammals; USDOI BLM and MMS, 2003, USDOI, BLM, 2004, 2005, 2006; USDOI, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004, 2006a,b,d).

Fishes. Chronic small-volume crude and refined spills from all operations associated with production (25/year) typically would be 29-126 gal (0.7-3 bbl) in size. Depending on the launch area, spills of this size could dissipate before reaching important fish habitats; however, the large number of spills may result in spills reaching coastal areas, i.e., one spill per 2 years. The small-volume spill rate included spills from a

future pipeline on land, and these spills could reach freshwater habitats used by fish. In the event of an onshore pipeline oil spill contacting a small waterbody supporting fish and having restricted water exchange, it likely would kill or harm most or all of the fish within the waterbody. If all of the fish in an isolated waterbody were killed, natural recovery would not occur. If habitats were restored and there was open exchange to other populated waterbodies, recovery would be likely in 5-10 years (see Sec. IV.C.1.d, Fish Resources; USDO I BLM and MMS, 2003, USDO I, BLM, 2004, 2005, 2006; USDO I, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004, 2006a,b,d).

Subsistence-Food Contamination. Small oil spills have the potential to impact subsistence-harvest resources and patterns indirectly, because subsistence users will reduce their harvests of a particular resource if they fear that the resource has been contaminated. An oil spill of any volume into a river system or lake could have effects on subsistence-fish harvests. Loss of some portion of the subsistence-fish harvest would negatively affect the majority of communities in the Proposed Action area. Subsistence users typically would allow some period of time for contaminated resources or areas to recover following exposure to oil, effectively reducing the total resource amount and the total harvest area acreage available to them for the subsistence harvest (USDO I BLM and MMS, 2003, USDO I, BLM, 2004, 2005, 2006; USDO I, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004, 2006a,b,d).

IV.C.1.l(1)(a)6) Traditional Knowledge on Effects from Discharges, Seismic Surveys, Noise, Disturbances, and Small Oil Spills.

Traditional Knowledge on Effects from Discharges and Contamination. Historically, the operation of communication sites by the military, and later contractors, resulted in contamination of surrounding areas with fuel, oil, antifreeze, and other chemicals, which led over time to avoidance of these areas by subsistence harvesters concerned about chemical contamination (USDO I, BLM, 2004).

Concerns about contamination extend beyond the study of measurable pollutants to the perception that there may be areas where unknown or unmeasured levels of contaminants in the environment could be affecting both the Inupiat and the resources they harvest. Contaminants may be present in small quantities deemed harmless, but may accumulate and have serious, long-term, and ongoing health consequences yet unstudied, for both the Inupiat and the species they on which they rely for subsistence (NRC 2003; USDO I, BLM, 2004).

The late Barrow elder, Thomas P. Brower, Sr., commented in a 1978 interview about whale sensitivities to pollution:

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. (NSB, 1980)

Onshore, Point Lay residents believe health problems of caribou are related to contaminants (Tucker, 1998).

Behavioral responses to the perception of contamination are as real as responses to measurable pollution. The current mayor of Nuiqsut, Rosemary Ahtuanguak, outlines stresses placed on resource users in response to real and perceived contamination:

There has been many problems with various developments. And there [are] by-products left all around, areas where you have worked and got your oil and it's left over. We go out and we travel around our land. We go hunting in this land. The by-products of these developments are definitely hurting us. We state that. But yet, in your book it says it's not to a level that's acknowledged as being harmful. Well, we are definitely being harmed by this development (Ahtuanguak, 1997, as cited in USDO I, MMS, 1997b; USDO I, BLM, 2004).

Contamination and the perception of contamination of subsistence resources may also affect the use of subsistence foods through reduced or abandoned harvests, increased stress about the effects of consuming possibly tainted food, concerns about future availability of subsistence resources, and a decline in the

satisfaction of eating subsistence food sources. Responses to known pollution reflect the importance of subsistence foods even in the face of measurable contamination, as a Nuiqsut resident testifying at a public meeting for the Alpine Satellite Development commented: “The ADF&G told us the burbot has mercury, pcbs in the liver, but I eat ‘em anyway” (USDOI, BLM, 2004).

Traditional Knowledge on Effects from Seismic Surveys.

Bowhead and Beluga Whales, Other Marine Mammals, and Birds. Local residents consistently have indicated that whales and other marine mammals are very sensitive to noise and have been disturbed from their normal patterns of behavior by past seismic activities. Whales can become less predictable and more dangerous to those who hunt them.

Inupiat concern over seismic-survey disturbance is well documented. Don Long from Barrow stated: “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, 1990c). Barrow resident Eugene Brower had similar fears about seismic-survey disturbance, believing that noise associated with drilling, seismic-survey, and other exploration activities will disturb the migration of the bowhead whales (Brower, 1995, as cited in USDOI, MMS, 1995a). The late Burton Rexford, then Chairman of the AEWC, described seismic-survey effects on whales in a 1993 symposium on Native whaling this way:

...I had the...experience in Barrow in 1979, 1980, and 1981 of geophysical seismic work in the ocean, and it's a “no-no” to a hunter during the whaling migration. I know from experience. There were three of us captains that went out whaling in the fall. In those three years, we didn't see one bowhead whale, and we saw no gray whales, no beluga, and no bearded seal. We traveled as far as 75 miles away from our home on the ocean waters in those three years. (McCartney, 1995; USDOI, MMS, 1998)

Tom Albert, former Inupiat Senior Scientist for the NSB, related that: “When a captain came in to talk to me, I knew he was going to say that the whales are displaced [by noise] farther than you scientists think they are. But some of them would also talk about ‘spookiness’; when the whales were displaced out there and when the whaler would get near them, they were harder to approach and harder to catch” (USDOI, MMS, 1997a, USDOI, MMS, Herndon, 2002).

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 NMFS, 1993). Expressing concern about 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, 1995b).

The late Thomas Napageak, former whaling captain, President of the Native Village of Nuiqsut, and AEWC Chairman, related in 1979 that he had not seen one whale while going to Cross Island and believed it was the result of seismic activity in the area (Napageak, 1979, as cited in USDOI, BLM, 1979b). 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 and 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 exploration activities on the outer continental shelf (State of Alaska, Dept. of Fish and Game, 1995). 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 surveying and transportation noise are of primary concern to Beaufort Sea residents because of their impacts on bowhead whales (Dames and Moore, 1996; USDOI, MMS, 2003a).

In a March 1997 workshop on seismic-survey effects conducted by MMS in Barrow, Alaska, with subsistence whalers from the communities of Barrow, Nuiqsut, and Kaktovik, whalers agreed on the following statement concerning the “zone of influence” from seismic-survey noise: “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” (USDOI, MMS, 1998).

The MMS conducted long-term environmental monitoring in the region for its ANIMIDA project and, as part of this effort, conducted a multiyear collaborative project with Nuiqsut whalers that 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 of monitoring 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; air and water traffic to the east of Cross Island; and generally poor weather (Galginaitis and Funk, 2004, 2005; USDOI, MMS, 2003a).

In 2002, more moderate ice conditions than in 2001 contributed to whalers not being able to follow certain whales, but not to the same extent as in 2001, when ice conditions were more severe and more whales and in larger groups were seen in 2002 than in 2001. Possible causes suggested by the whalers for these behavioral changes were better ice conditions and very little nonwhaling subsistence activity near Cross Island during the whaling season (Galginaitis and Funk, 2004).

In 2003, conditions were not as good as in 2000 and 2002; however they may have been better or about the same as in 2001, and more whales were observed by whalers during hunting trips in 2003 than in 2002. Possible causes suggested by the whalers were high winds and the lack of ice that could have moderated the effect of the wind (Galginaitis, 2005).

Ice conditions in 2004 were even more moderate than in previous years, and weather prevented scouting for whales on a significant number of days, but not as many days as in 2003. The level of whaling effort, as measured by time spent out on the water, was about twice that of 2003, but still much less than in 2002 or 2001. Whalers found whales relatively close to Cross Island. Possible causes suggested by the whalers were the lack of ice that could have moderated the effects of the wind, weather being generally poor, whales having been more difficult to spot due to wave height, and whales possibly traveling more rapidly than in past years (Galginaitis and Funk, 2006a).

In 2005, whalers encountered a great deal of ice, which was a dramatic change from the previous 4 years. Weather also was very unfavorable, and was dominated by strong east winds. Whalers saw relatively few whales in 2005 compared to previous years, and swells and waves due to wind made spotting and observing difficult; in most cases, they were not able to follow or chase whales long enough to have a good opportunity for a strike. Whalers indicated that whales were traveling fast, not staying on the surface very long, and changing directions in unpredictable ways when first sighted. Possible causes suggested by the whalers were heavy ice cover allowed whales to “hide” and made them more difficult to spot and allowed them to escape more easily and made them more difficult to follow, “spooked” whale behavior was attributed to their reactions to encounters with barges and other vessel activity in the area, the same ice and weather conditions made nearshore waters the preferred operating areas for non-whaling-vessel traffic and increased potential encounters with whalers (Galginaitis and Funk, 2006b). The ANIMIDA monitoring suggests that changing ice conditions can be as disruptive to the local hunt as anthropogenic disturbance from seismic and other noise-producing activities, and, according to Galginaitis: “the need for a better mechanism to implement the common goal of conflict avoidance for years of extreme environmental conditions as 2005 is quite obvious” (Galginaitis and Funk, 2006b).

Caribou and Other Terrestrial Mammals. After World War II, seismic exploration was a problem to the reindeer, and Brower remembers the seismic wire catching in the hooves of the reindeer and making them lame (Arundale and Schneider, 1987). Fifty years later, seismic activity still is a problem. Karen Burnell, then NSB Planning Director, indicated at the March 1997 Atqasuk Northeast NPR-A Scoping Meeting that

inspection of seismic crews is necessary to keep their activities in line with permitting guidelines that require them to adequately clean up small spills and pick up debris left behind (USDOI, BLM and MMS, 1997, 2003).

Subsistence Access. Barrow and Nuiqsut residents testified that recent onshore seismic activity does interfere with overland snowmachine travel (Brower, 2002). Specifically, the deep ruts left in the snow by seismic vehicles create difficult terrain to traverse, and result in excessive wear and tear on both snowmachines and the sleds that are pulled behind them. Replacement or repair of these tools that are used for subsistence harvesting is costly (USDOI, BLM, 2006).

Traditional Knowledge on Effects from Noise and Disturbance.

Aircraft and Vessel Support.

Bowhead Whales. Many Inupiat whale hunters express a traditional belief that whales can detect sounds much farther than can be measured by scientific instruments. This traditional belief implies that whales can perceive sounds and changes in the environment that cannot be detected by hearing, as hearing is defined by science. By traditional terms, whales also may be able to “hear” electromagnetic waves from radio broadcasts, hear sounds in the water or in the air for hundreds of miles, and understand what people are saying about them anywhere in the whale’s yearly movements and react accordingly. The end result is that the whales may decide to either make or not make themselves available to hunters based on the sounds they hear or how people behave toward them. This premise is applied to other animal species as well (Burch, 1999). Traditional knowledge about the spiritual ability of whales to “hear” varies from place to place and from person to person (U.S. Army Corps of Engineers, 2005).

During spring whaling, pilots flying in and out of Barrow are asked not to fly planes over ice leads, no outboards are used unless they are towing a whale, and no duck hunting takes place in or near whaling camps or from whaling boats. Hunters in the Barrow and Point Hope areas keep dogs, snowmachines, and camps behind ice ridges so the noise will not be heard in leads where whales may move. Hunters in Kivalina chartered planes to search for open leads, but the planes land long before the hunters arrive at the leads to hunt. The whaling camp in the Point Hope area was kept clean, and smelly things were kept to the north of the hunters, because the whales migrated from the south. If the hunter had to urinate or defecate, they would do it on the ice to the north of the boat so the whale would not smell the unpleasant odors and avoid them. At Barrow, burning is not permitted at the dump (Lowenstein, 1981; Burch, 1985; George, 1996; U.S. Army Corps of Engineers, 2005).

According to the late Burton Rexford, former chairman of the AEW: “Loud noises drive the animals away.... We know where whales can be found; when the oil industry comes into the area, the whales aren’t there. It is *not* the ice; it is the noise” (NMFS, 1993; USDOI, MMS, 1998).

The late Barrow elder, Thomas P. Brower, Sr., began whaling in 1917 as a boy. 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 (NSB, Commission on History and Culture, 1980; USDOI, MMS, 2003a).

One of the most serious concerns to North Slope Inupiat is that potential increases in noise from oil development could disrupt normal migration of bowhead whales, forcing subsistence whalers into longer hunts farther from shore. 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 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 permanent structures 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 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, 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, 2001b)

Expressing concern about aircraft disturbance, a Nuiqsut resident and whaling captain said in 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, 1995b).

Patsy Tukle from Nuiqsut also expressed this sentiment. He explained that helicopters and ships 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; USDOI, MMS, 2003a).

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, 1996).

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).

Wainwright residents object to nearshore or offshore disturbances of any kind because of the displacement of game they have already observed (Aveoganna, 1987; Oktullik, 1996). Residents expressed concerns about potential contamination from oil and about oil-spill-cleanup capabilities (Aveoganna, 1987; Kagak, 1987). Local residents state explicitly that there are no viable substitutes for subsistence-food resources (Ahmaogak, 1987). Hunters have observed waste sites and contamination and the changes that have occurred to fish, caribou, and polar bear behavior and to local ocean conditions (Peetook, 1998; Angashuk, 1998; D. Tagarook and G. Tagarook, 1998). There is a local concern that BLM, in its planning protocol for NPR-A, would designate certain areas off limits to subsistence (Peetook, 1998). Also of concern to the community is the ongoing issue of impact assistance to local communities from oil-activity impacts (Agnasagga, 1986). The Traditional Knowledge in this paragraph all are from USDOI, BLM and MMS, 2003).

Herman Rexford from Kaktovik recounts that oil ships affect the migration of the whales. He would like to see no ships or exploration off of Kaktovik during the fall whaling time. He knows that the ships are noisy and can affect whaling routes (Rexford, 1986, as cited in USDOJ, MMS, 1986b). Herman Aishanna, former Kaktovik vice-mayor, recounted that “tugs make a lot of noise in the summertime” (Aishanna, 1996, as cited in Dames and Moore, 1996).

Barrow whaler Gordon Brower, stated in his comments on MMS’ 2007-2012 Proposed 5-Year Leasing Program:

Barrow whalers and Nuiqsut whalers have encountered “unacceptable levels’ of disturbance from industrial activities in these waters, where whales were harvested far from ideal locations. The result was putting the Inupiat hunters in a greater danger by deflecting the whales as far as 30 miles off course; some boat[s] have succumbed to storms and greater wave actions and sunk; in some cases, individuals lost their lives. The harvest of the whale, therefore, was spoiled, after a 12-hour tow or more; the whale gasifies its internal organs and contaminates the meat, and the whale at this point cannot be eaten. This is a direct impact to feeding the indigenous Inupiat people of the Arctic. In Barrow alone, it takes a minimum of 10 whales to feed the community for a day, for the season’s events. Our culture is surrounded by the whale (Brower, 2005).

Beluga Whales. Hunters have identified noise as affecting beluga whales. Noise from any source traditionally is unacceptable in the whaling cultures of northern Inupiaq and Chukotka peoples (Huntington and Mymrin, 1996; Lowenstein, 1994; Morseth, 1997; Huntington, 1999; Mymrin, 1999). Hunters believe that beluga whales have excellent underwater hearing and, for this reason, hunters tend to communicate in quiet tones and with hand signals, trying to make no excessive noise (Lowenstein, 1981; Burch, 1985; George, 1996; U.S. Army Corps of Engineers, 2005). A common theme among the Northwest Alaska coastal communities and along the eastern shore of the Chukotka Peninsula is that beluga whales are sensitive to noise and to the noise of outboard motors in particular (Huntington and Mymrin, 1996; Huntington, 1999; Mymrin, 1999). The observations about the effects of noise on beluga whales are widespread and probably very old in traditional knowledge. Negative reactions of belugas to outboard engines in the Kotzebue Sound area were recognized in the 1950’s and 1960’s and reported in scientific literature as early as 1983 (Fejes, 1996; Foote and Cook, 1969; Frost, Lowry, and Nelson, 1983; U.S. Army Corps of Engineers, 2005).

Kivalina hunters observed that belugas are intelligent and have learned to associate the sound of an outboard engine with danger. They report that Kotzebue hunters hunt with larger and faster boats, and the beluga have learned to go to deeper water when they hear the outboard engine noise from these faster boats. The implication is that beluga retain their experiences with high-speed boats in Kotzebue Sound, making them more wary as migrate northwestward toward Kivalina of hunters in boats with outboard motors. Belugas are known to avoid hunters in boats with outboards in Cook Inlet and Kotzebue Sound and can recognize the sound of individual motors used to capture them near Point Lay for satellite-tagging studies (Morseth, 1997; Braund, 1999; Huntington, 1999; U.S. Army Corps of Engineers, 2005).

Local Native hunters in Kivalina are concerned that operational noise, shipping noise, and the presence of the Red Dog port facilities deflect the nearshore migration of the summer beluga stock farther offshore and away from around the port facilities and Kivalina hunting areas, making them less accessible to hunters. Noise from other sources, particularly outboard motors, also is blamed. Port facilities are not operated during the spring beluga migration, but ice colliding with the pilings and repair and maintenance work can produce noise that is transmitted into the water. Some hunters believe port-facility noise, combined with the beluga’s memory of past noise at the site, and the physical presence of the facilities, may cause beluga whales to avoid coastal waters near the port area during the spring migration (Braund, 1999, 2000; U.S. Army Corps of Engineers, 2005).

Seals and Other Marine Mammals. 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 NMFS, 1993).

Caribou and Other Terrestrial Mammals. According to studies and public scoping comments, low-altitude helicopter and scientific survey flights divert subsistence species from air-transport corridors and

survey transects. Nuiqsut mayor Rosemary Ahtuanguak described an incident of displacement of subsistence species by aircraft and its effect on hunters:

When I went camping last year, I waited 3 days for the herd, to have a helicopter to divert them away from us. When they were diverted, we went without. We have had to deal with harassment. We had overflights three times while trying to cut the harvest. It is disturbing. The next year we had a helicopter do the same thing, but it was worse. They were carrying a sling going from Alpine to Meltwater, another oil field. It went right over us three times. The herd was right there, and it put us at risk. I had my two young sons with me, and it made me very angry. What am I to do when the activities that have been handed down for thousands of years to our people are being changed by the global need for energy? (Mayor Rosemary Ahtuanguak, USDO, BLM, 2004)

Other Nuiqsut residents stated: “Sometimes the aircraft from Alpine chase the caribou up the river,” and “Helicopters are flying around when we are doing caribou and geese hunts. Before Alpine, there was complete silence.” (S.R. Braund and Assocs., 2003, Field Interviews, USDO, BLM, 2004)

Hunters tend to relate aerial activity with subsistence resource deflection. One hunter stated:

It varies whether we have a lot of activities going on. When there are a lot of activities going on, we hardly see any or they [caribou] change their migration route. Oil and gas, airplanes, helicopters, bird survey people—airplane, floatplanes. Either there are less caribou or they are changing migration with activities. I don’t know which. (S.R. Braund and Assocs., 2003, Field Interviews, USDO, BLM, 2004)

Birds. 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 USDO, BLM, 1979b).

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 NMFS, 1993).

Wildlife studies, some associated with monitoring and oil- and gas-planning activities, prompted a Nuiqsut resident to observe:

These wildlife folk that see it—they’ve witnessed, I guess they are wildlife folks, that walk in the country and [are] looking at birds and things in the Colville River Delta, maybe the east side, down by Ulumniak (ph), that’s next to—not far from the old Nuiqsut site, they’re monitoring these birds and go to and from these places with a chopper—upsets, disrupts, displaces—perhaps some of [our] only opportunity to go get...game, especially caribou, in the area are scared and may...run off because of these impediments that arrive [and] are not natural. Naturally, [we] would walk along the coast where they’re at and be able to harvest...caribou. (Ruth Nukapigak, as cited in USDO, BLM, 1998)

It is important to note that aircraft used for biological surveys have the greatest likelihood of affecting subsistence-harvest patterns because they cover a large area, last a long time relative to other research activities, and are known to elicit responses from caribou and waterfowl (Nukapigak, 1998; Ahtuanguak, 2003, Kaigelak, 2003, Olemaun, 2003, as cited in USDO, BLM, 2005).

Fishes. 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). 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 USDO, MMS, 1983a).

Subsistence Access. Nuiqsut residents have noted that aircraft have diverted subsistence resources away from areas where hunters were actively pursuing them, directly interfering with harvests or causing harvests to fail (USDO, BLM 2004). If resources are diverted from traditional areas, increased travel

distances for hunters result in greater expenditures for fuel and equipment because of greater wear and tear on snowmachines, outboards, and four-wheel vehicles. Nuiqsut subsistence users have stated repeatedly that aircraft traffic reduces harvest access and success (Nukapigak, 1998, Ahtuanguaruak, 2003, Kaigelak, 2003, Olemaun, 2003, cited in USDO, BLM, 2005).

Drilling.

Barrow resident Arthur Neakok maintained that ice presents an extreme hazard to ships and drilling (Neakok, 1990, as cited in USDO, MMS, 1990b). At the same hearing, Eugene Brower expressed concern that multiyear ice would cause problems during drilling (Brower, 1990, as cited in USDO, MMS, 1990b).

Bowhead and Beluga Whales and Other Marine Mammals. Local residents consistently have indicated that whales and other marine mammals are very sensitive to noise and have been disturbed from their normal patterns of behavior by past drilling activities. Oil activities can make whales become less predictable and more dangerous to hunt. Fenton Rexford from Kaktovik stated that during exploratory drilling in Canadian waters to the east of Kaktovik “we were not successful or had a very hard time in catching our whale when there was activity with the SSDC [single steel drilling caisson], the drilling rig off Canada. And it diverted [bowhead whales] way offshore; made it difficult for our whalers to get our quota” (testimony cited in USDO, MMS, 1996d). Herman Aishanna reported that in 1985, the SSDC affected Kaktovik whaling even though the rig was idle – “We got no whales that year” (USDO, MMS, 2001b).

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 USDO, BLM, 1979b).

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 also 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 USDO, MMS, 1990b).

Construction.

Bowhead Whales. 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. 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 USDO, MMS, 1983a). 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 USDO, MMS, 1983a).

Beluga Whales and Other Marine Mammals. For Point Lay residents, beluga whales are a prized subsistence resource; for this reason, Point Lay residents object to nearshore or offshore noise disturbances (Tukrook, 1987; Tucker, 1996). Hunters believe such nearshore or offshore development would disturb migrating whales, change migration routes, and make them impossible to hunt or adversely affect their population (Huntington and Mymrin, 1996). Point Lay residents have expressed concern about the overall health of caribou, beluga whales, polar bears, brown bears, wolves, and wolverines in the area (Stalker, 1998).

Kivalina traditional knowledge as it relates to construction and operation noises at the Red Dog port facilities states that these activities have affected the subsistence harvest of beluga whales in the area. The total Kivalina harvest of beluga whales declined between 1984 and 1987, even before construction began

on the Red Dog port site and the has continued to be low in the years since. In other marine waters of Alaska, and in other seas of the world, belugas have adapted to industrial and transportation noises after they have learned that those noises do not represent a direct threat. Beaufort Sea and Cook Inlet data indicate that the presence and operation of marine transportation facilities have not caused long-term avoidance by belugas (Huntington and Mymrin, 1996). Kivalina hunters contend that either belugas of both spring and summer stocks have not yet become acclimated to port facilities and disturbance or that other factors such as (1) long-term changes in ice conditions, (2) beluga mass mortality reported in Siberian waters, and (3) changes in beluga response to increased noise and activity may have caused the decline in the beluga harvest since port site construction began in the late 1980's (U.S. Army Corps of Engineers, 2005).

Caribou and Other Terrestrial Mammals. Inupiat hunters have observed the effect of roads and pipelines on caribou movement in Prudhoe Bay, Kuparuk, and other locations, and one hunter summarized ongoing effects:

The Prudhoe Bay spine road is like a gate: the caribou get corralled in the area by roads, traffic, pipeline reflections, and staging. They get confused. They are scared to cross the pipelines, they are as scary as a grizzly bear would be to the animals. Some caribou are driven south, others are driven to the coast. If more roads are built, then there will be more blockage of the caribou. They will get stuck in the oil fields like a corral. The ones stuck south stay south and get little insect relief, while those going north get to the beach and the coast and get relief (S.R. Braund and Assocs., 2003, Field Interviews, USDO, BLM, 2004)

One Nuiqsut hunter observed: "Caribou movement patterns have changed. The herd splits along the pipeline where they used to go straight through, and they congregate in smaller groups spread further apart. Main parts of the herd split either north or south of Alpine, all trying to head towards insect relief" (S.R. Braund and Assocs., 2003, Field Interviews, USDO, BLM, 2004).

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. 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 (Pedersen et al., 2000; USDO, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004, 2006a,b; USDO, BLM, 2004, 2005).

Construction of onshore support facilities would reduce access within current subsistence-use areas as hunters avoid construction areas because of perceived regulatory barriers, loss of cultural privacy, and safety concerns with shooting near industrial development. Ongoing impacts on the community of Nuiqsut are discussed below, because such impacts are emblematic of potential impacts on other subsistence communities in the region.

As a consequence of oil development (based on Pedersen et al., 2000 and Pedersen and Taalak, 2001), Nuiqsut caribou hunters tend to avoid development, with approximately 78% of the 1993 and 1994 caribou harvests occurring >16 mi from the development east of the Colville River, 51% of the 1999-2000 harvests occurred >16 mi, and 27% occurred 6-15 mi from Alpine development. Construction of new facilities would contribute to Nuiqsut residents' perceptions of being surrounded by oil development. Oil and gas development could divert subsistence users a distance of 5->25 mi from development facilities. Given rapidly rising fuel costs on the North Slope, this additional travel would add considerable cost to subsistence harvests (USDO, BLM, 2004, 2005).

Leonard Lampe, president of the Native Village of Nuiqsut, expressed his belief of the effect of increased traffic on caribou, when he said:

...I feel because of all the traffic between Fairbanks and Endicott, much more increased traffic, that caribou are hesitant to cross the main roads because of all the traffic. I feel that has something

to do with the caribou migration as well, because of increased [air] traffic...not just ground, as well as...seismic operations happening all over. (Lampe, 1997; USDO, BLM, 1998)

Two years later, Mayor Leonard Lampe stated at an MMS Liberty Project Information Update Meeting in November 1999 that people in Nuiqsut 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 (USDO, BLM, 2004; 2005).

Pipelines can deter hunting because of the inherent safety concerns involved with hunting near them. One Nuiqsut resident stated:

We don't go down that way to caribou hunt because of the pipeline in there; it is a big obstruction. A lot of times they [caribou] are on the pipeline side and we don't shoot. They [industry] tell us it is OK to shoot, but common sense says not to shoot into pipeline! (S.R. Braund and Assocs., 2003, Field Interviews, USDO, BLM, 2004)

Other hunters observed changes in the Nuiqsut area in response to existing development, noting that: "Most caribou don't cross Nigliq to Fish Creek anymore. There is noise, activity, traffic, and pipelines." Hunters have observed caribou reactions to pipelines, with one hunter stating: "Some [caribou] get used to pipelines, but it takes years. Shiny pipes and pipes that vibrate feel like a living thing to the caribou and it scares them" (S.R. Braund and Assocs., 2003, Field Interviews, USDO, BLM, 2004).

Atqasuk residents have expressed concern for areas critical to calving caribou and nesting waterfowl and have suggested that special management zones be established for these populations. Hunters believe oil development has affected animal migrations and duck populations near Prudhoe Bay and recommend that development should not occur any closer than 15-20 mi to their habitats (Kagak, 1997). Arnold Brower, Sr. remembers returning from World War II and noticing the extensive environmental damage left by the Navy. He believed that damage done by the Navy near Imagruaq Lake damaged the tundra to such an extent that a drainage ditch was created that lowered the lake's water level and ruined fishing there. After the War, Navy exploration continued and Thomas Brower, Sr., remembers having to negotiate with the Navy so their planes would not buzz his reindeer herd (Arundale and Schneider, 1987; USDO, BLM and MMS, 1997, 2003; USDO, BLM, 2005).

Some residents of Kivalina and Noatak affirm that the Red Dog road corridor may be avoided by caribou and possibly by other animals. Hunters in the region have stated that road traffic has at times adversely affected the caribou harvest.

In winter, ice roads also are a problem. One Nuiqsut hunter noted: "People that use the ice road leave trash, and animals eat that trash. Caribou and polar bears—have trash inside of them. Seals—plastic pop rings. Within the last 5 years, on the ice road, [I] see a lot of trash all over" (S.R. Braund and Assocs., 2003, Field Interviews, USDO, BLM, 2004).

Caribou habituation to gravel pads and oil-field infrastructure alters the value of the caribou to subsistence users, who view these habituated caribou as contaminated and not behaving correctly. Frank Long, Jr., stated in the Nuiqsut Alpine Satellite Development Project scoping meeting:

We will have the same problem we did in the Prudhoe Bay and the Kuparuk area with our caribou. Right now I call our caribou that are existing around here that don't go nowhere our 'industrial dope addict caribou.' They already sick and nobody's doing anything about them. (USDO, BLM, 2004)

Sick caribou are increasingly harvested by local hunters. One Nuiqsut hunter related: "I've seen a few sick caribou, with green meat, pus in joints, bare spots. Hard to say what the cause is..." (S.R. Braund and Assocs., 2003, Field Interviews, USDO, BLM, 2004). Pedersen and Taalak (2001) reported five sick caribou harvested that year. Inupiat hunters prefer fast, healthy caribou, instead of habituated caribou, that are perceived to move slower and do not run away from hunters. One hunter stated: "Fast ones are the

healthy ones, they are worth taking home” (S.R. Braund and Assocs., 2003, Field Interviews, USDO, BLM, 2004).

Gravel pads create habitat for arctic foxes, which den in the loose gravel of the pad, but an increase in foxes is not necessarily an advantage to subsistence hunters because, as stated by Nuiqsut elder Bessie Ericklook in 1979: “Trapping was abundant east of here. Now, we don’t go over [there] because of the oilfield. Just recently, it is known that the foxes are very dirty, discolored, and rabid in that area. Trapping is done elsewhere” (USDO, BLM, 1979c).

Birds. An Inupiat hunter from Barrow observed wildlife displacement associated with gravel pits. He observed that:

These gravel pits that are being used to support these activities, the gravel pits, the geese, when they’re migrating from the Lower 48, from out there, they are now going to these gravel pits. They’re not following their usual migration anymore. I watched that first hand...over a period of time. So those animals over there are being displaced, is what I’m saying. And I got to see that firsthand over a period of time. (Frederick Tukle, Sr. as cited in USDO, MMS, 2002)

Such diversion of migratory waterfowl can reduce access and availability of these resources to Inupiat hunters.

Atqasuk residents expressed concern for areas critical to nesting waterfowl and have suggested that special management zones be established for these populations. Hunters believe oil development has affected animal migrations and duck populations near Prudhoe Bay and recommend that development should not occur any closer than 15-20 mi to their habitats (Kagak, 1997; Arundale and Schneider, 1987; USDO, BLM and MMS, 1997, 2003; USDO, BLM, 2005).

Fishes. 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 AEW, 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 Ahtuanguak, from Nuiqsut, maintained almost 2 decades ago that there “aren’t as many whitefish since the oil companies started drilling at Flaxman Island” (Ahtuanguak, 1979, as cited in USDO, BLM, 1979a); Joseph Akpik, from Nuiqsut, asserted that offshore exploration would affect the cisco population (Akpik, 1995, as cited in USDO, MMS, 1995a; USDO, BLM, 2005).

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 USDO, BLM, 1979a).

Subsistence hunter Isaac Nukapigak from Nuiqsut observed that cisco are not spawning near the Colville Delta anymore, explaining that oil activities in State waters there are having an effect (Nukapigak, 1995, as cited in USDO, MMS, 1995a). 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 USDO, MMS, 1983a).

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 [1992], and that there used to be 100-200 fish caught per day versus 6-9 per day now (USDO, MMS, 2002).

Arnold Brower, Sr. remembers returning from World War II to Atqasuk and noticing the extensive environmental damage left by the Navy. He believed that damage done by the Navy near Imagruaq Lake damaged the tundra to such an extent that a drainage ditch was created that lowered the lake's water level and ruined fishing there (USDOI, BLM and MMS, 1997, 2003; USDOI, BLM, 2005).

Ice roads that are grounded to the bottom of waterways change the normal patterns of breakup and reduce fish habitat. One subsistence fisher described his recent hunting trip by boat: "A few days ago [late June], the ice was out 7 miles; we followed it to Thetis Island. Usually the ice is out around Thetis Island, but the ice road was intact and it kept the ice from going out. We almost got boxed in" (S.R. Braund and Assocs., 2003, Field Interviews, USDOI, BLM, 2004).

Polar Bears. Trash has become an issue in subsistence areas close to oil- and gas-related facilities. A Nuiqsut hunter explained that: "People that use the ice road leave trash, and animals eat that trash. Caribou and polar bears—have trash inside of them. Seals—plastic pop rings. Within the last 5 years, on the ice road, [I] see a lot of trash all over" (S.R. Braund and Assocs., 2003, Field Interviews, USDOI, BLM, 2004).

Subsistence Access. Subsistence hunters have expressed a preference for hunting away from industrial activity areas for safety and other reasons. As noted in NRC (2003): "Even where access is possible, hunters are often reluctant to enter oil fields for personal, aesthetic, or safety reasons. There is, thus, a net reduction in the available area, and this reduction continues as the oil fields spread." Reduction in available area would alter access, and this change in access would result in increased effort, cost, and risks associated with traveling farther (USDOI, BLM and MMS, 1997, 2003; USDOI, BLM, 2004, 2005).

Barrow resident Charles Brower, as early as 1986, stated 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).

Local Nuiqsut residents have expressed concerns about access restrictions. Sarah Kunaknana stated that others say that subsistence hunters do not hunt near Prudhoe Bay anymore because of oil development (Kunaknana, as cited in Shapiro, Metzner, and Toovak, 1979). 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 that access to subsistence resources will be restricted. In view of the areas near Prudhoe now off limits to subsistence, access issues are viewed as critical. Arnold Brower, Jr., NSB Northeast Area NPR-A Coordinator, said that similar firearm restrictions from NPR-A leasing and development with those already existing around Prudhoe Bay oil-development sites would create additional detours for subsistence hunters (Ahvakana, 1990, as cited in USDOI, MMS, 1990d; USDOI, BLM and MMS, 1997, 2003; USDOI, BLM, 2004, 2005).

Concerns about restricted subsistence access on the North Slope, particularly around Nuiqsut, take on even more meaning as the Northstar Project, development at the Alpine field, and leasing in the NPR-A 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 had traditional rights to be there. They did 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 offshore at Liberty Island. They prefer to travel within the barrier islands because the islands offer protection from the open sea (Dames and Moore, 1996b; USDOI, BLM, 2004).

Nuiqsut residents have concerns over pipeline construction restricting subsistence access and have told BLM that it must identify stipulations to protect subsistence-hunting sites, traditional fish camps, and access routes from development impacts (C. Brower, as cited in USDOI, MMS, 1986a; Hepa, 1997).

Project Engineering. 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. In light of the recent BPXA onshore spill at Prudhoe Bay, these fears do not seem unfounded (Dames and Moore, 1996b; Mufson, 2006).

Traditional Knowledge on Effects from Small Oil Spills.

Bowhead Whales and Other Marine Mammals. In a Statewide survey conducted from 1992-1994 by the Alaska Department of Fish and Game, Division of Subsistence, 60% of the respondents in Nuiqsut believed that industry could not contain and clean up even a small oil spill (State of Alaska, Dept. of Fish and Game, 1995; Fall and Utermohle, 1995; Impact Assessment, Inc., 1998; Field et al., 1999).

IV.C.1.i(1)(b) Effects from Large Oil Spills. The chance of one or more large spills occurring does not factor in the chance that a development project occurs. Given the many logistical, economic, and engineering factors, there is probably a <10% chance that a commercial field will be leased, discovered, and developed. However, because leasing and exploration could lead to a development project, MMS must evaluate what could happen if a development occurred even though the chance of that happening probably is very small in a frontier area like the Chukchi Sea. If a development occurs, the OSRA more accurately represents the chance of one or more spills occurring.

The Sale 193 oil-spill-trajectory model discusses the movement of large spills that are defined as $\geq 1,000$ bbl. The large spill sizes assumed are (1) a production facility platform spill of 1,500 bbl for crude or diesel oil and (2) an offshore pipeline spill of 4,600 bbl of crude oil. A large spill could occur at any time during the year and, depending on the time of year, a spill could reach the following environments: ice, broken ice, under ice, open water, shoreline, tundra, and snow. The oil weathering model simulates scenarios where a spill occurs in open water and another where a spill freezes into the ice and melts out into 50% ice cover. Open water is June through October; a winter spill melts out in June. After 30 days in open water or broken ice, 40-57 % of the oil evaporates, 2-53% disperses, and 0-55% remains. After 30 days under landfast ice, nearly 100% of the oil remains in place and unweathered and does not move significantly until the ice breaks up. The analysis assumes no cleanup or containment. Cleanup and containment are considered mitigating factors.

The overall chance of one or more large oil spills occurring and contacting is calculated from an OSRA model. The time and chance of contact from an oil spill are calculated from an oil-spill-trajectory model. The chance of contact is analyzed from the location where it is highest when determining effects. For purposes of analysis, for Alternative I (Proposed Action), Alternative III (Corridor I Deferral), and Alternative IV (Corridor II Deferral), one large spill is assumed to occur and is analyzed in this EIS.

Large oil spills probably are the most significant potential source of adverse effects attributable to the Proposed Action. Negative effects to specific subsistence species, as well as to the more general patterns of subsistence resource use, persisted in Prince William Sound for several years after the EVOS and the subsequent cleanup effort. The EVOS demonstrated that a very large spill could affect Prince William Sound as well as the east coast of the Kenai Peninsula and the beaches of the Kodiak/Shelikof Strait area. This spill was 75 times as large as the spills analyzed as part of the proposed scenario, indicating that tanker spills often are much larger than platform or pipeline spills. A pipeline or platform spill could affect subsistence activities, and such effects would reduce the availability and/or accessibility of subsistence resources, potentially for periods longer than a single harvest season (USDOI, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004, 2006a,b,d).

The effects of a large spill on subsistence are expected to be significant in the Chukchi Sea Sale 193 Proposed Action area. An oil spill $\geq 1,000$ bbl could, depending on the time and location of the spill event, affect the subsistence use of marine mammals in the region where it occurs. Marine mammals are the most important subsistence resource, both conceptually as well as in terms of food, for the region. The bowhead whale hunt could be disrupted, as could the hunts for beluga whale, bearded seal, and walrus and other marine mammals generally. Animals could be directly oiled, or oil could become part of the icefloes they use on their northern migration. Such animals may be considered undesirable and more difficult to hunt because of the physical conditions. Animals are also likely to be "spooked" or wary, either because of the spill itself or from the "hazing" of marine mammals, which is a standard spill-response technique to encourage them to leave the area affected by a spill. There has been little experience with under-ice or broken-ice oil spills, and local residents have little confidence in industry's current capability to successfully clean them up.

While the concern most typically is phrased in terms of the potential effects of oil spills on whales and whaling, it can be generalized to a concern for marine mammals and ocean resources in general. Marine mammals and fishes typically comprise 60% of a coastal community's diet, and the ocean is frequently referred to in public testimony as "the Inupiat garden." Pipeline and platform spills also could affect migrating anadromous fishes in the river deltas, as well as species that use oiled coastal and nearshore habitat, such as breeding caribou and nesting birds.

Other effects from potential oil spills, such as food tainting and cleanup disturbance, could occur after a spill event. An oil spill affecting any part of the migration route of the bowhead whale could taint this 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 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.

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, as well as subsistence users on the Russian arctic coast of Chukchi Sea. Tainting concerns about oiled or tainted resources in these communities seriously could curtail traditional practices for harvesting, sharing, and processing important subsistence species because all communities would share concerns over the safety of subsistence foods and whale food products and the health of the whale stock.

Large spills could affect subsistence patterns by reducing populations of subsistence species, contaminating subsistence species or their habitats, or rendering resources unfit to eat. These effects could reduce the amount of subsistence foods harvested, cause changes in traditional diets, increase risks and wear and tear on equipment if users were required to travel farther to obtain subsistence resources, and cause social stress due to the reduction or loss of preferred foods harvested in the traditional fashion (USDOI BLM and MMS, 2003; USDOI, BLM, 2004, 2005, 2006; USDOI, MMS, 1987c, 1990b, 1998, 2001b, 2003a, 2004, 2006a,b,d).

For Sale 193 Alternative I, no large spills are assumed to occur during exploration activities. For the development and production phase, a 1,500-bbl spill from a platform or a 4,600-bbl spill from a pipeline are assumed. The chances of either spill contacting specific ERA's would be the same. The 1,500-bbl spill would cover a smaller area (577 km² in summer) than the 4,600-bbl spill (1,008 km² in summer) after 30 days. Only the 4,600-bbl spill is discussed in the following, as it represents the highest range of potential contact and impact.

IV.C.1.1(1)(b)1 Conditional Probabilities. A 4,600-bbl spill could contact ERA's where important subsistence resources are present. The following discussion presents conditional and combined probabilities estimated by the OSRA model (expressed as a percent chance) of a spill contacting or occurring and contacting subsistence-resource areas. Conditional probabilities are based on the assumption that a large spill has occurred. Combined probabilities, on the other hand, factor in the chance of the one or more large spills occurring. Oil-spill contact in winter could affect polar bear hunting and sealing. During the open-water season, a large spill could affect bird hunting, sealing, and whaling, as well as netting of fish in the ocean.

For each community below, the following paragraphs discuss summer conditional probabilities located in Appendix A.2 Tables A.2-27, A.2-30, A.2-33, A.2-36, A.2-45 and A.2-48 in the first paragraph and then winter conditional probabilities located in Appendix A.2 Tables A.2-27, A.2-30, A.2-51, A.2-54, A.2-63 and A.2-66 in the second paragraph. Maps showing the ERA, LS and BS locations discussed are located in Appendix A.1; ERA's (Maps A.1-2a-2d), LS's (Maps A.1-3a-3c), and BS's (Map A.1-1).

Barrow. The OSRA model estimates a <0.5% chance of a large oil spill starting at LA1-LA13 contacting ERA 41 (Barrow Chukchi Sea whaling and subsistence area) within 30 days, and a <0.5-1% chance of

contact from LA1-LA13 over a 360-day period; for ERA 42 (Barrow Beaufort Sea whaling and subsistence) there is a <0.5-8% chance within 30 days, and a <0.5-14% chance of contact from a large spill starting at LA1-LA13 over a 360-day period. For ERA 41, there is a <0.5% chance of contact from P1-P11 within 30 days and a <0.5-1% chance of contact in 360 days; for ERA 42 there is a <0.5-3% chance of contact from P1-P11 within 30 days and a <0.5-5% chance of contact in 360 days. Land Segments 82 (Skull Cliff), 83 (Nulavik), 84, (Walakpa River), 85 (Elson Lagoon), 86 (Dease Inlet), 87 (Kurgorak Bay), 88 (Cape Simpson), 89 (Smith Bay) and 90 (Drew Point/Kolovik) have a <0.5-9% chance of contact from a larger spill originating at LA1-LA13 for 30 days and a <0.5-13% chance of contact for 360 days (LS 90 is <0.5%). For a large spill originating at P1-P11, there is a <0.5-11% chance of contact for 30 days and a <0.5-13% chance of contact for 360 days (with LS 90 <0.5%).

Winter-contact percentages generally are higher. For a 30-day period, they range from <0.5% starting at LA8-LA13 for ERA 41 (ERA 42 is <0.5%), and <0.5-6% for both ERA's over a 360-day period starting from LA1-LA13. For 30 days, there is a <0.5-9% chance of contact from P9-P11 for ERA 41 (ERA 42 is <0.5%), and a 1-15% chance of contact from P2-P11 for 360 days. Land Segments 82-85 have a <0.5-2% chance of contact within 30 days from a large spill originating at LA8-LA13 and P11; LS's 82-88 have a <0.5-7% chance of contact within 360 days from a spill originating at LA1-LA13 and P1-P11.

Wainwright. The OSRA model estimates a <0.5-21% chance of a large oil spill starting at LA4-LA13 contacting Wainwright's subsistence ERA 40 within 30 days and a 1-29% chance of contact from LA1-LA13 over a 360-day period. There is a <0.5-53% chance of contact from P1-P11 within 30 days, and a <0.5-60% chance of contact in 360 days. Land Segments 76 (Avak Inlet/Tunalik River), 77 (Nivat Point/Nokotlek Point), 78 (Point Collie/Sigeakruk Point), 79 (Point Belcher/Wainwright), 80 (Eluksingiak Point/Kugrua Bay), and 81 (Peard Bay/Point Franklin) have a <0.5-4% chance of contact from a large spill originating at LA11-LA13 for 30 days and <0.5-6% chance of contact for 360 days. From a spill originating at P5-P11, there is a <0.5-11% chance of contact for 30 days and a <0.5-13% chance of contact for 360 days.

In winter, contact percentages for a 30-day period, range from <0.5-7% starting at LA4-LA13 for ERA 40, and 1-20% over a 360-day period from LA1-LA13. For 30 days, there is a <0.5-38% chance of contact from P2-P11, and a 1-56% chance of contact from P1-P11 for 360 days. The LS's 78-80 have <0.5-1% chance of contact within 30 days from a spill originating from LA12 (LS 76, 77 and 81 have values <0.5%) and a 3% chance of contact from a spill originating at P9. Land Segments 76-80 have a <0.5-4% chance of contact within 360 days from a spill originating at LA4-L13 and a <0.5-10% chance from a spill originating at P3-P11.

Point Lay. The OSRA model estimates a <0.5-15% chance of a large oil spill starting at LA4-LA13 contacting Point Lay's subsistence ERA 39 within 30 days and a <0.5-19% chance of contact from LA4-LA13 over a 360-day period. There is a <0.5-45% chance of contact from P1-P9 within 30 days and a <0.5-48% chance of contact in 360 days. Land Segments 70 (Kuchaurak/Kuchiak Creek), 71 (Kukpowruk River/Sitkok Point), 72 (Point Lay/Siksriyak Point), 73 (Tungaich Point/Tungak Creek), 74 (Kasegaluk Lagoon/Solivik Island), and 75 (Akeonik, Icy Cape) have a <0.5-3% chance of contact from a summer spill originating at LA4-LA12 for 30 days and <0.5-4% chance of contact for 360 days. From a spill originating at P2-P9, there is a <0.5-9% chance of contact for 30 and 360 days.

In winter, contact percentages for a 30-day period, range from <0.5-15% starting at LA4-LA11 for ERA 39, and <0.5-25% over a 360-day period from LA1-LA12. For 30 days, there is a <0.5-36% chance of contact from P2-P6, and a <0.5-42% chance of contact from P1-P9 for 360 days (see Tables A.2-27, A.2-30, A.2-51, and A.2-54). Land Segments 71-75 have a 1-3% chance of contact within 30 days from a spill originating from LA10-LA11 (LS 70 has values <0.5%), and LS's 70-75 have a <0.5-7% chance of contact from a spill originating at P3-P6. Land Segments 70-75 have a <0.5-5% chance of contact within 360 days from a spill originating at LA4-LA12 and a <0.5-9% chance from a spill originating at P2-P9.

Point Hope. The OSRA model estimates a <0.5-8% chance of a large oil spill starting at LA4-LA11 contacting Point Hope's subsistence ERA 38 within 30 days during summer, and a <0.5-8% chance of contact from LA4-LA11 over a 360-day period. There is a <0.5-24% chance of contact from P1-P6 within 30 days and a <0.5-24% chance of contact in 360 days. Land Segments 63 (Asikpak Lagoon/Cape Seppings), 64 (Kukpuk River/Point Hope), 65 (Buckland/Cape Lisburne), and 66 (Ayugatak Lagoon) have

a <0.5-3% chance of contact from a summer spill originating at LA4-LA10 for 30 days and <0.5-3% chance of contact for 360 days from a spill originating at LA4-LA11 (LS 62, Atosik Lagoon/Kuropak Creek, has values <0.5%). From a spill originating at P1-P6, there is a <0.5-9% chance of contact for 30 and 360 days.

In winter, the only contact percentage greater than 0.5% for a 30-day period, is 2% from LA9 for ERA 38, and 1-2% over a 360-day period from LA9-LA10. For 30 days, there is a <0.5-12% chance of contact from P1-P3, and a <0.5-14% chance of contact from P1-P6 for 360 days (see Tables A.2-27, A.2-30, A.2-51, and A.2-54). Point Hope LS's 62-66 all have a <0.5% chance of contact within 30 days from a spill originating from LA1-LA13. The LS's 64 and 65 have a <0.5-2% chance of contact from a spill originating from P1-P3. Land Segments 64 and 65 have a 1% chance of contact within 360 days from a spill originating at LA9 and a <0.5-4% chance from a spill originating at P1-P3 (LS 62, 63, 65, and 66 all have a <0.5% chance of contact).

Kivalina. The OSRA model estimates a <0.5% chance of a large oil spill starting at LA1-LA13 contacting Kivalina subsistence ERA 13 within 30 and 360 days during summer. There is a 1% chance of contact from P1 within 30 and 360 days. Land Segments 58 (Cape Krusenstern/Kasik Lagoon), 59 (Ipiavik Lagoon/Omikviorok River), 60 (Kivalina/Wulik River), 61 (Cape Seppings/Pusaluk Lagoon), and 62 (Atosik Lagoon/Kuropak Creek) have a <0.5% chance of contact from a summer spill originating at LA1-LA13 for 30 and 360 days and from PA1-PA11 for 30 and 360 days.

In winter, contact percentages for the 30-day and 360-day periods are <0.5% for ERA 13 and LS's 58-62 for spills originating from LA1-LA13 and PA1-PA11.

Kotzebue and Vicinity. The OSRA model estimates a <0.5% chance of a large oil spill starting at LA1-LA13 contacting Kotzebue and vicinity subsistence ERA's 13 and 5 within 30 and 360 days during summer. There is a 1% chance of contact from P1 within 30 and 360 days. Land Segments 47 (Kitluk River/West Fork Espenberg River), 48 (Cape Espenberg/Espenberg River), 49 (Kungealoruk Creek/Pish River), 50 (Clifford Point/Sullivan Bluffs), 51 (Cape Deceit/Toawlevic Point), 52 (Motherwood Point/Willow Bay), 53 (Kiwalik/MudCreek), 54 (Baldwin Peninsula/Lewis Rich Channel), 55 (Cape Blossom/Pipe Spit), 56 (Kinuk Island/Noatak River), 57 (Aukulak Lagoon/Sheshalik Spit), and 58 (Cape Krusenstern/Krusenstern Lagoon) all have a <0.5% chance of contact from a large spill originating at LA1-LA13 for 30 and 360 days and from PA1-PA11 for 30 and 360 days.

In winter, contact percentages for the 30-day and 360-day periods are <0.5% for ERA's 13 and 5 and LS's 47-58 for spills originating from LA1-LA13 and PA1-PA11.

Shishmaref. The OSRA model estimates a <0.5% chance of a large oil spill starting at LA1-LA13 and PA1-PA11 contacting Shishmaref subsistence ERA 5 within 30 and 360 days. Land Segments 40 (Ah-Gude-Le-Rock/Mint River), 41 (Ikpek/Yankee River), 42 (Arctic Lagoon/Nuluk River), 43 (Sarichef Island/Shishmaref Airport), 44 (Cape Lowenstern/Shishmaref), 45 (Shishmaref Inlet/Cowpack Inlet), 46 (Cowpack Inlet/White Fish Lake), 47 (Kitluk River/West Fork Espenberg River), 48 (Cape Espenberg/Espenberg River) have a <0.5% chance of contact from a large spill originating at LA1-LA13 for 30 days and 360 days and from PA1-PA11 for 30 days and 360 days.

In winter, contact percentages for the 30-day and 360-day periods are <0.5% for ERA 5 and LS's 40-48 for spills originating from LA1-LA13 and PA1-PA11.

Wales. The OSRA model estimates <0.5% chance of a large oil spill starting at LA1-LA13 and PA1-PA11 contacting Wales subsistence ERA 5 within 30 and 360 days. Land Segments 40 (Ah-Gude-Le-Rock/Mint River), 41 (Ikpek/Yankee River), and 42 (Arctic Lagoon/Nuluk River) have a <0.5% chance of contact from a large spill originating at LA1-LA13 for 30 days and 360 days and from PA1-PA11 for 30 days and 360 days. There is 1% chance of contact to Boundary Segment 2 (Eastern Bering Strait) from a spill originating at LA 9 and P1 for 30 and 360 days during summer.

In winter, contact percentages for the 30-day and 360-day periods are <0.5% for ERA 5 and LS's 40-42 for spills originating from LA1-LA13 and PA1-PA11. During winter, there is 1% chance of contact to

Boundary Segment 2 (Eastern Bering Strait) from a large spill originating at LA 9 for 30 and 360 days and a 2% chance of contact from a spill from P1 for 30 and 360 days.

Russian Arctic Chukchi Sea Coastal Communities. The OSRA model estimates a <0.5-7% chance of a large oil spill starting at LA4-LA10 within 30 and 360 days during summer and contacting the Enermino/Neshkan/Alyatki marine mammal harvest ERA 3. There is a 1-3% chance of a spill starting at LA9-LA10 within 30 and 360 days during the summer contacting the Naukan/Uelen/Inchoun/Chegitun marine mammal harvest ERA 4. For ERA 3 there is a <1-7% chance of contact from P1-P3 within 30 and 360 days; for ERA 4 there is a <0.5-3% chance of contact from P1-P3 within 30 and 360 days during summer.

Land Segments 7 (Kosa Bruch), 8 (Klark/Mys Uering), and 9 (Nasha/Bukhta Rodzhers) are potential harvest areas for the community of Ushakovskoe on Wrangel Island (pop. estimated 8). Land Segments 7, 8 and 9 have a <0.5% chance of contact from summer and winter spills originating at LA1-LA13 and P1-P11 for 30 days. Land Segment 8 has a 1% chance of contact from a summer spill originating from LA8, LA 13, and P2 for 360 days. Land Segments 7 and 8 have a 1% chance of contact within 360 days from a spill originating at LA1 and LS 8 a 1% chance from a spill originating at LA2, P2 and P4 during winter.

Land Segments 14 (InnuKay/Mys Veuman), 15 (Laguna Adtaynung/Lagina Uvargina), and 16 (Mys Emmatagen/Uvargin) are potential harvest areas for the community of Billings (pop. 272). In summer and winter, contact percentages for the 30-day and 360-day periods are <0.5% for these land segments for spills originating from LA1-LA13 and PA1-PA11.

Land Segments 18 (Mys Enmykay/Laguna Rypil'khin), 19 (Laguna Kuepil'khin/Leningradskii), 20 (Kuekvun'/Tynupytku), and 21 (Laguna Kinmanyakicha/Val'korkey) are potential harvest areas for the communities of Leningradskii (pop. 835), Pil'gyn (pop. unknown), and Polyarny (pop. unknown). In summer and winter, contact percentages for the 30-day and 360-day periods are <0.5% for these land segments for spills originating from LA1-LA13 and PA1-PA11.

Land Segments 21, 22 (Ekiatan'/Rypkarpi), and 23 (Emuem/Tenkergin) are potential harvest areas for the communities of Rypkarpi (pop. 915) and Cape Shmidt (pop. 717). In summer and winter, contact percentages for the 30-day and 360-day periods are <0.5% for these land segments for spills originating from LA1-LA13 and PA1-PA11.

Land Segments 26 (Ekugvaam/Pil'khin), 27 (Laguna Nut/Rigol'), 28 (Kamynga/Laguna Vankarema), and 29 (Akanatkhyrgyn/Vel'may) are potential harvest areas for the communities of Rigol' (pop. unknown) and Vankarem (pop. 186). In summer and winter, contact percentages for LS's 26, 28, and 29 for the 30-day period are <0.5%. Land Segment 27 has a 1% chance of contact for 30 days in summer from LA4 and LA9. For 360 days, LS's 26-29 have a 1% chance of contact for summer spills from LA4, LA8, LA9, and P1. In winter, for 360 days, LS's 26-29 have a 1% chance of contact from LA1, LA4, LA9, P1, and P2.

Land Segments 29, 30 (Laguna Kunergin/Laguna Pyngopil'khin), and 31 (Alyatki/Kolyuchin Bay) are potential harvest areas for the community of Nutpel'men (pop. 155). In summer and winter, contact percentages for LS's 29-31 for the 30-day period are <0.5%. For 360 days, LS's 29-31 have a 1% chance of contact for summer spills from LA9, and P1-P3. In winter, for 360 days, LS's 29-31 have a 1-2% chance of contact from LA4, LA9, and P1-P3.

Land Segments 30, 31, 32 (Mys Dzhenretlen/Lit'khekay-Polar Station), and 33 (Neskan/Mys Neskan) are potential harvest areas for the communities of Alyatki (seasonal camp?) and Neshkan (pop. 628). In summer contact percentages for LS's 30-32 for the 30-day period are <0.5%. Land Segment 33 has a 1% chance of contact from a summer spill after 30 days. In winter, contact percentages for LS's 30-33 for the 30-day period are <0.5%. For 360 days, LS's 30-33 have a 1-2% chance of contact for summer spills from LA9, LA10, P1, and P3. In winter, for 360 days, LS's 30-33 have a 1-3% chance of contact from LA4 and LA9, and a 1-2% chance of contact from P1-P3.

Land Segments 34 (Emelin/Tepken), 35 (Enurmino/Mys Neten), and 36 (Mys Chechan/Mys Serditse Kamen) are potential harvest areas for the community of Enurmino (pop. 304). In summer, LS's 34-36 have a 1-2% chance of contact from spills originating from LA9 and P1 and in winter a <0.5-1% chance of

contact from spills originating LA9 and P1 for 30 days. For 360 days, LS's 34-36 have a 1-3% chance of contact for summer spills from LA9, LA10, P1, and P3. In winter, for 360 days, LS's 34-36 have a 1-5% chance of contact from LA9-LA11, and a 1-6% chance of contact from P1 and P3.

Land Segments 36, 37 (Chevgtun/Mys Volnistyy), and 38 (Enmytagyn/Mys Unikin) are potential harvest areas for the community of Chegitun (seasonal camp?). Land Segments 36-38 have a 1-2% chance of contact from spills originating from LA9, P1, and P3 for 30 days during summer. In winter there is 1% chance of contact to LS 36 from spills originating at P1 for 30 days; contact percentages for LS's 37 and 38 are <0.5% for winter spills. For 360 days, LS's 36-38 have a 1-2% chance of contact for summer spills from LA9 and a 1% chance of contact from P1 and P3. In winter, for 360 days, LS's 36-38 have a 2-4% chance of contact from LA9 and a 1-5% chance of contact from P1 and P3.

Land Segments 37, 38, and 39 (Cape Dezhnev/Mys Uelen) are potential harvest areas for the communities of Inchoun (pop. 362), Uelen (pop. 678), and Naukan (pop. 359). Land Segments 37-39 have a 1-2% chance of contact from spills originating from LA9 and P1 for 30 days during summer. In winter there is 1% chance of contact to LS 39 from spills originating at P1 for 30 days; contact percentages for LS's 37 and 38 are <0.5% for winter spills. For 360 days, LS's 37-39 have a 1-2% chance of contact for summer spills from LA9 and a 1% chance of contact from P1 and P3. In winter, for 360 days, LS's 37-39 have a 1-3% chance of contact from LA9 and a 1-5% chance of contact from P1 and P3.

IV.C.1.I(1)(b)2 Combined Probabilities. Combined probabilities express the percent chance of one or more oil spills $\geq 1,000$ bbl occurring and contacting a certain environmental resource area or land segment over the production life of Chukchi Sea Sale 193. The combined probabilities discussed are located in Appendix A.2 Tables A.2-75, A.2-78, A.2-81 and A.2-84. The OSRA model estimates a <0.5% chance of one or more large oil spills occurring from a platform or a pipeline (LA1-LA13 or P1-P11, respectively) and contacting subsistence specific ERA's 3 (Russian coastal communities subsistence), 4 (Russian coastal communities subsistence), 5 (Wales and Shishmaref subsistence), 13 (Kotzebue region and Kivalina subsistence), 41 (Barrow/Chukchi Sea subsistence), and 42 (Barrow/Beaufort Sea subsistence) within 30 days over the production life of Alternative I. The OSRA model estimates the chance of one or more large spills occurring and contacting is 1% for ERA 38 (Point Hope subsistence), 5% for ERA 39 (Point Lay subsistence), and 4% for ERA 40 (Wainwright subsistence) within 30 days over the production life of Alternative I.

For 360 days, the OSRA model estimates a <0.5% chance of one or more large spills occurring from a platform or a pipeline (LA1-LA13 or P1-P11, respectively) and contacting subsistence specific ERA's 3, 4, 5, 13, and 41 within 360 days over the production life of Alternative I; there is a 1% chance of occurrence and contact for (Barrow/Beaufort Sea subsistence ERA 42). The OSRA model estimates a chance of one or more large spills occurring and contacting is 1% for ERA's 38 and 42, 7% for ERA 39, and 8% for ERA 40 within 360 days over the production life of Alternative I.

The OSRA model estimates a 1% chance of one or more large oil spills occurring and contacting LS's 72-75 (Point Lay) within 30 days, and a 1% chance one or more large oil spills occurring and contacting within 360 days for LS's 65 (Point Hope), 71-75 (Point Lay), and 78-80 (Wainwright) over the production life of Alternative I.

The potential for bowhead whales to be contacted directly from an oil spill from Sale 193 is relatively small except in areas off Point Lay and Wainwright, but the potential chance of contact to whale habitat, whale-migration corridors, and subsistence-whaling areas in the Chukchi Sea (both Russian and American waters) is considerably greater. Onshore areas and terrestrial subsistence resources, in general, would to have a lower potential for oil-spill contact.

IV.C.1.I(1)(b)3 Effects from a Large Oil Spill on Subsistence Resources.

Bowhead Whales. In the event of a large oil spill, the probability of oil contacting whales is 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 it is likely that some whales would experience temporary, nonlethal effects from the oiling of skin, inhaling hydrocarbon vapors, ingesting oil-

contaminated prey, fouling of their baleen, losing their food source, and temporary displacement from some feeding areas. Some whales could die as a result of contact with spilled oil. 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. There is uncertainty about effects on bowheads (or any large cetacean) in the event of a large spill. There are, in some years and in some locations, relatively large aggregations of feeding bowhead whales within the proposed sale area. If a large amount of fresh oil contacted a significant portion of such an aggregation, effects potentially could be greater than typically would be assumed, and we cannot rule out population-level effects if a large number of females and newborn or very young calves were contacted by a large amount of fresh crude oil. Oil-spill-response activities (including active attempts to move whales away from oiled areas) could cause short-term changes in local distribution and abundance. 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 (see Sec. IV.C.1.f(1), Threatened and Endangered Marine Mammals).

Beluga Whales, Seals and Other Marine Mammals. For beluga whales, there also is uncertainty about effects on them in the event of a very large spill. There are, in some years and in some locations, relatively large aggregations of feeding and molting whales within the Planning Area. If a large amount of fresh oil contacted a significant portion of such an aggregation, effects could be greater than typically assumed; and population-level effects cannot be ruled out, if a large number of females and newborn or very young calves were contacted by a large amount of fresh crude oil. Available information indicates it is unlikely that whales would be likely to suffer significant population-level adverse effects from a large spill originating in the Chukchi Sea. However, individuals or small groups could be injured or potentially even killed in a large spill, and oil-spill-response activities (including active attempts to move whales away from oiled areas) could cause short-term changes in local distribution and abundance. For walrus, an oil spill impacting haulout areas could have a significant impact on the Pacific walrus population, although the chance of contact to haulout areas is small. Little information is known about oil-spill effects on seals although any large oil spill in nearshore marine or coastal riverine environments could cause injury or death to these sea mammals, potentially cause them to move off of their normal course, and make them unavailable for subsistence harvest (see Sec. IV.C.1.h, Other Marine Mammals).

Caribou and Terrestrial Mammals. Caribou can frequent barrier islands and shallow coastal waters during periods of heavy insect harassment and could 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 could be exposed to oil if a spill contaminates the ice. 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. Significant weight loss and aspiration pneumonia leading to death are possible adverse effects of oil ingestion in caribou. Caribou that become oiled by contact with a spill in coastal waters could die from toxic hydrocarbon inhalation and absorption through the skin. Similar effects would be expected for muskoxen. 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 Chukchi Sea coast, some grizzly bears and arctic foxes are likely to ingest contaminated food, such as oiled birds, seals, and 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. An oil spill in a coastal river would have greater impacts to local grizzly bear populations, particularly if it occurred during an active salmon run.

If a platform or pipeline oil spill occurred during the open-water season or during winter and melted out of the ice during spring, some caribou frequenting coastal habitats could be directly contaminated by the spill along the beaches and in shallow waters during periods of insect-pest-escape activities. 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 to the overall population of a particular caribou herd (see Sec. IV.C.1.i, Terrestrial Mammals).

Birds. The greatest potential for substantial adverse impacts on marine and coastal birds typically would come from large volume oil spills in important coastal bird habitats. These areas are Kasegaluk Lagoon, Peard Bay, barrier islands, the spring open-water lead system, and the seabird-nesting colonies at Cape Lisburne and Cape Thompson. Oil spills have the greatest potential for affecting large numbers of birds in part due to toxicity to individuals and their prey and the difficulties involved in cleaning up spills in remote areas, given the wide variety of possible ice conditions. A large spill could impact large number of murre, puffins, and kittiwakes at the Cape Lisburne and Cape Thompson colonies. The magnitude of potential mortality could result in significant adverse impacts to the colonies. Similarly, large-scale mortality could occur to pelagic distributions of auklets and shearwaters during the open-water period and male and juvenile murre in the late summer. Kasegaluk Lagoon, Peard Bay, colonies at Cape Thompson and Cape Lisburne, the open-water Spring-Lead System, and barrier islands provide important nesting, molting, and migration habitat to a variety of waterfowl and shorebirds. Spills during periods of peak use could affect large numbers of birds. Up to 45% of the estimated Pacific Flyway population of Pacific brant could be affected if an oil spill reached Kasegaluk Lagoon. Effects could range from direct mortality of approximately 60,000 brant to sublethal effects on an equal or smaller number of brant. The loss of up to 45% of the Pacific Flyway population would have conspicuous population-level effects. The situation with brant is similar to a wide variety of waterfowl and shorebirds that use similar areas of the Chukchi Sea (see Sec. IV.C.1.g, Marine and Coastal Birds).

Fish. A large oil spill impacting intertidal or estuarine spawning and rearing habitats used by capelin or other fishes potentially could result in significant adverse impacts to some local breeding populations. Recovery to former status by dispersal from nearby population segments would require more than three generations. Given a lack of contemporary abundance and distribution information, large oil spill effects on rare or unique species (including potential extirpation) could occur, but would likely go unnoticed or undetected. Depending on the timing, extent, and persistence of a large spill, some distinct runs of pink and chum salmon could be eliminated. Recovery from this significant adverse impact would only occur as strays from other populations colonized the streams after the oiled habitats recovered. These local fish stocks would not be available for subsistence harvest for many years (see Sec. IV.C.1.d, Fish Resources).

Polar Bears. For polar bears, if an offshore oil spill occurred, a significant impact to polar bears could result, particularly if areas in and around polar bear aggregations were oiled. This is because the biological potential for polar bears to recover from any perturbation is low due to their low reproductive rate (see Sec. IV.C.1.h, Other Marine Mammals).

Russian Arctic Chukchi Sea Coastal Communities. Potentially, important coastal lagoons and nearshore subsistence-harvest areas for beluga, gray and bowhead whales, walrus, seals, fishes, and birds could be contacted in the event of a large oil spill. Intensive industrialization, massive immigration, forced acculturation, and the collapse of Soviet economic and employment supports have taken a huge toll on the indigenous peoples of the region. These conditions have, ironically and out of necessity, brought coastal Native peoples closer to nature and turned them again toward their traditional reliance on hunting and fishing of marine resources, and their traditional diet of marine mammals, fish, marine invertebrates, and other locally harvested resources such as small game. In some cases, population and industrial declines have led to lower anthropogenic pressures on ecosystems, but more often these conditions have increased poaching levels due to increased unemployment and the lack of adequate food supplies. Effects from a large oil spill could exacerbate existing stresses on local resource populations and the local hunt, causing significant impacts to indigenous coastal communities (Newell, 2004; Nuttall, 2005; Schweitzer, 2005, pers. commun.).

IV.C.1.1(b)4 Subsistence Practices. Large spills could affect subsistence patterns by reducing populations or availability of subsistence species, contaminating subsistence species or their habitats, producing tainting concerns in resources, and rendering resources as unfit to eat. These effects could reduce the amount of subsistence foods harvested, cause changes in traditional diets, and increase risks and wear and tear on equipment if users were required to travel farther to obtain subsistence resources.

In addition to impacts to subsistence-resource populations, a large oil spill could produce tainting and cleanup disturbance. An oil spill affecting any part of the migration route of the bowhead whale and other marine mammals 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 uncontaminated resources should continue.

Concerns about tainting also would apply to polar bears and seals and 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. A spill originating within the Chukchi Sea region could produce indirect impacts 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 (including indigenous people on the Russian Chukchi Sea coast) and Bering seas adjacent to the migratory corridor used by whales and other migrating species.

Onshore, the greatest potential impact from a large spill would result if the spill occurred in the spring, just before breakup, and resulted in a release of crude oil into a river or stream below the ice, which in turn was released during breakup into the nearshore coastal waters of the Chukchi Sea. If oil were spilled in a waterway in large volumes, waterfowl, fish, and marine mammals could be fouled, contaminated, or killed. A large spill would be toxic immediately to fish and could contaminate them for years, even in apparently cleaned habitats. Waterfowl and marine mammal populations could be affected by the death of animals from hypothermia caused by oiling, reactions to toxic components of spilled oil, and gastric distress resulting from attempts to clean themselves. In addition, scavengers feeding on their remains, such as foxes, also could be harmed.

There also is concern that the IWC, 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 whaling communities.

Tainting concerns could seriously curtail the harvesting, sharing, and processing of subsistence resources, and these practices would be hampered to the degree these resources were contaminated. 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. In the case of extreme contamination, harvests could cease until such time as resources were perceived as safe by local subsistence hunters. Because all communities would share concerns over the safety of these subsistence foods and the health of the whale stock, social stress would occur from the reduction or loss of preferred foods harvested in the traditional fashion and threaten a pivotal element of indigenous Alaska culture. 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.1.l(1)(b)5 Effects from Cleanup Activities on Subsistence Resources.

Bowhead Whales. 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. There are no described observations concerning the level of disturbance on bowhead whales from cleanup activities, although the presence of offshore skimmers, workboats, barges, aircraft overflights, and in situ burning during cleanup are expected to cause whales to temporarily alter their swimming direction and cause temporarily displacement (USDOI, MMS, Herndon, 2002; USDOI, MMS, 2003a).

Beluga Whales and Other Marine Mammals. In the case of a winter spill, when few important subsistence marine mammal 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. It is possible that cleanup operations could displace some ringed seals from maternity dens during the winter, resulting in the loss of a few seal and walrus pups. If a large oil spill occurred, contacted, and extensively oiled coastal habitats during the open-water season, the presence of cleanup personnel, boats, and aircraft operating in the cleanup area is expected to displace beluga whales, seals, and walrus and to contribute to increased stress and reduced pup survival of ringed seals, if operations occur during the spring. These effects may occur during 1 or 2 years of cleanup; however, we do not expect it to greatly affect seal, walrus, and beluga whale behavior and movement beyond the area (within about 1 mi) of the activity or after cleanup (Impact Assessment, Inc., 1998; USDO, MMS, 2003a, USDO, BLM 2004).

Caribou and Other Terrestrial Mammals. If a large oil spill occurred, contacted, and extensively oiled 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 could seriously stress the herd, resulting in increased mortality or decreased productivity. For most spills, control and cleanup operations at the spill site would frighten animals away from the spill and prevent them from grazing on oiled vegetation. For the most part, effects are likely to occur only during cleanup operations (1-2 seasons) and are not expected to significantly affect caribou herd movements or foraging activities. Cleaning up a large oil spill also would disturb some muskoxen, grizzly bears, and arctic foxes (USDO, BLM, 2006; USDO, MMS, 2003a).

Birds. 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 (USDO, MMS, 2003a).

Fishes. Because of the low density of fish in the Chukchi 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 (USDO, MMS, 2003a).

Polar Bears. If a large oil spill occurred, contacted, and extensively oiled coastal habitats, the presence of cleanup personnel, boats, and aircraft operating in the cleanup area is expected to displace polar bears. It is possible that cleanup operations could displace some bears from maternity dens during the winter, resulting in the loss of a few bear cubs. These effects may occur during 1 or 2 years of cleanup; however, we do not expect it to greatly affect polar bear behavior and movement beyond the area (within about 1 mi of the activity) 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 be effective in preventing polar bears from entering the oiled water (Impact Assessment, Inc., 1998; USDO, MMS, 2003a, USDO, BLM 2004).

Subsistence. Spill-cleanup strategies potentially would reduce the amount of spilled oil in the environment and tend to mitigate spill-contamination effects, especially in the case of a winter spill when few important subsistence resources would be present and cleanup is likely to be fairly effective. Disturbance to bowhead and beluga whales, seals, walrus, caribou, fish, birds, and polar bears would increase from oil-spill

cleanup activities for spills occurring during breakup or the open-water season. 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 are normally harvested or to become more wary and difficult to harvest. Cleanup disturbance would affect polar bears within about 1 mile of the activity. 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.

Subsistence hunting also would be impacted by any spill that required the local knowledge, experience, and vessels of local whaling captains. Diverting effort and equipment to oil-spill cleanup would adversely impact the subsistence whale hunt (and other harvesting activities). 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. The overall result would be a major effect on subsistence harvests and subsistence users, who would suffer impacts on their nutritional and cultural well-being. Impacts subsistence harvests and subsistence users would be significant if they persisted for more than a single harvest season (Impact Assessment, Inc., 1998; USDO, MMS, 2003a, USDO, BLM, 2004).

IV.C.1.1(1)(b)6 Traditional Knowledge on Effects from A Large Oil Spill and Cleanup.

Bowhead Whales. Marie Adams, 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 USDO, MMS, 1990b).

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 USDO, MMS, 1990b).

Having been a whaler since 1916, elder Thomas P. Brower, Sr., from Barrow, in a 1978 interview, gave an extraordinary account of an oil spill in the Arctic and its effects:

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. (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.

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 USDOJ, BLM, 1982). 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 USDOJ, MMS, 1995c).

Beluga Whales and Other Marine Mammals. 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 USDOJ, MMS, 1990d).

Point Lay hunters believe nearshore or offshore development and oil spills would disturb migrating [beluga] whales, change migration routes, and make them impossible to hunt or adversely affect their population (Huntington and Mymrin, 1996). Point Lay residents have expressed concern about the overall health of caribou, beluga whales, polar bears, brown bears, wolves, and wolverines in the area (Stalker, 1998, as cited in USDOJ, BLM and MMS, 2003).

Wainwright residents expressed concerns about potential contamination from oil and about oil-spill-cleanup capabilities (Aveoganna, 1987; Kagak, 1987). Local residents state explicitly that there are no viable substitutes for subsistence food resources (Ahmaogak, 1987). Hunters have observed waste sites and contamination and the changes that have occurred to fish, caribou, and polar bear behavior and to local ocean conditions (Peetook, 1998; Angashuk, 1998; D. Tagarook and G. Tagarook, 1998; USDOJ, BLM and MMS, 2003).

Caribou and Other Terrestrial Mammals. Point Lay residents have expressed concern about the overall health of caribou, beluga whales, polar bears, brown bears, wolves, and wolverines in the area (Stalker, 1998). Hunters believe health problems of caribou are related to contaminants (Tucker, 1998; USDOJ, BLM and MMS, 2003).

Birds. Maggie Kovalsky, from Nuiqsut, expressed the fears 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).

At hearings for the Northstar Project, Fenton Rexford from Kaktovik 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)

Fish. 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 USDOJ, MMS, 1983a).

Project Engineering. 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 (State of Alaska, Dept. of Fish and Game, 1995a). Ice forces can be unpredictable, and Frank Long, Jr., 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 USDOJ, 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).

Residents of Barrow are 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 USDOJ, MMS, 1983b).

Eugene Brower from Barrow expressed the general concern that spill-cleanup procedures under ice do not exist (Brower, 1990, as cited in USDOJ, 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 USDOJ, MMS, 1995b).

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 USDOJ, MMS, 1995a).

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 USDOJ, 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 (USDOJ, 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 USDOJ, 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).

IV.C.1.1(2) Effectiveness of Mitigation Measures. Several standard mitigation measures are assumed to be in place for the Chukchi Sea Sale 193, and this assumption is reflected in discussions about effects. Mitigation that would apply to subsistence-harvest patterns includes the standard stipulations below.

IV.C.1.1(2)(a) Standard Mitigation. 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 (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 No. 4 – Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources requires lessees proposing to conduct exploratory drilling operations, including seismic surveys, during the bowhead whale, beluga whale and walrus migrations (and during the presence of polar bears) to conduct site-specific monitoring programs 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), the Ice Seal Commission (ISC), the Alaska Beluga Whale Committee (ABWC), the Alaska Eskimo Walrus Commission (EWC), and the Nanuk Commission (NC) for polar bear determines that a monitoring program is not necessary. The monitoring program would assess when bowhead and beluga whales, walrus, and polar bears are present in the vicinity of lease operations and the extent of behavioral effects on them due to these operations.

This stipulation helps to provide mitigation to potential effects of oil and gas activities on the local Native whale and marine mammal hunters and subsistence users. It is considered positive mitigation under Environmental Justice. Other positive aspects of this stipulation in terms of subsistence and sociocultural concerns would be the involvement of the Native community and legally mandated co-management organizations 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-Harvest 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, Wainwright, Point Lay, and Point Hope; the North Slope Borough; the Alaska Eskimo Whaling Commission; the Alaska Beluga Whale Committee; the Alaska Eskimo Walrus Commission; the Ice Seal Commission; and the Nanuk Commission about the proposed operations. These consultations ensure that they coordinate siting and timing with subsistence whaling, marine mammal hunting, and other subsistence-harvest activities.

In the event no agreement is reached between the parties, the lessee, the AEWC, the ABWC, the EWC, the NC, and the NSB, the 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, the AEWC, the ABWC, the EWC, the ISC, the NC, the NSB, NMFS, and the lessee(s) to specifically address conflicts 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. Existing mitigation requires operators to coordinate siting and timing of projects in a CAA. 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. A recent example of this process is the CAA coordinating the timing of seismic activities for the 2006 seismic survey season in the Chukchi and Beaufort Seas with the subsistence whale hunt.

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 on subsistence harvest resources and practices, sociocultural systems, and Environmental Justice. This stipulation has proven to be effective mitigation in prelease (primarily seismic activities) and exploration activities and through the development of oil/whaler agreements between the Alaska Eskimo Whaling Commission and oil companies.

Stipulation 6 - Pre-Booming Requirements for Fuel Transfers would require pre-booming of the fuel barges for fuel transfers (excluding gasoline transfers) of 100 bbl 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 and other marine mammals from potential fuel spills that could occur prior to or during the migration periods. This stipulation would be an added caution in reducing potential harm to migrating bowhead and beluga whales, other marine mammals, and to any tainting of whales and marine mammals from a spill.

IV.C.1.1(2)(b) Mitigation Specific to Seismic Surveying. The following section discusses mechanisms for protecting subsistence-harvest activities from the possible impacts associated with seismic surveys. An operator could propose to conduct seismic-survey activity in an area critical to whaling during the whaling season; however, if this condition did occur, potential conflict could be mitigated by the cessation of activities during the whale migration. Theoretically, the larger the exclusion zone coupled with shut-down procedures, the greater protection of marine mammals from potential harassment and injury; thus, a 120-dB isopleth-safety zone would afford more protection from harassment and injury for marine mammals than a 180/190-dB isopleth-exclusion zone. The more marine mammals are protected, the more subsistence-harvest activities are protected. A current concern by local whalers is that increased industrial noise levels in the Beaufort and Chukchi seas will force hunters to travel farther to find whales and that this may lead to reduced success and an increased struck and lost rate for hunters that may, in turn, cause the IWC to reduce

the bowhead whale quota.

Because fall ice conditions are not predictable events, user conflicts between vessels and whalers due to bad ice conditions could produce a situation difficult to mitigate. This problem has been reported once for the Alaskan Arctic. In fall 1985, extreme ice conditions curtailed the length of Kaktovik's whaling season and, at the same time, caused vessels traveling to their overwintering sites to operate near whaling locations (Smythe, 1987, pers. commun., as cited in USDOJ, MMS, 1990a).

As a result of this conflict, a cooperative program was formed in 1986 between the NSB, the AEW, the Nuiqsut and Kaktovik whaling captains, and those petroleum companies interested in conducting geophysical studies and activities in the Beaufort Sea. This program was approved through a Memorandum of Understanding between NOAA and the AEW pursuant to the 1983 Cooperative Agreement, as amended. The 1986 Oil/Whalers Working Group established a communication system and guidelines to assure that industry vessels avoided interfering with or restricting the bowhead whale hunt and to establish criteria whereby the oil industry would provide certain kinds of assistance to the whalers. The program was successful for 2 years; however, it has been discontinued due to some difficulties with the communication systems and equipment. The Oil/Whalers Working Group cooperative program was a good example of how interference with a subsistence harvest can be effectively mitigated. In the absence of such mitigation, such a curtailment of the whale-harvest season due to noise could cause bowhead whales to become locally unavailable for the harvests in Kaktovik, Nuiqsut, Barrow, Wainwright, and Point Hope (USDOJ, MMS, 1990b).

Presently, individual companies coordinate with the whalers through the auspices of the AEW. Such coordination was a requirement under MMS leases for Beaufort Sea and Chukchi Sea Sales 97,109, 144, 170, 186, and 195. The working protocol is for the company to submit a letter stating that cooperation will occur.

The MMS, along with industry, their contractors, scientists, the NSB Mayor's Office, the NSB Wildlife Management Department, and the AEW, participate in the NMFS annual Peer Review Workshop to address monitoring issues as they relate to the NMFS administration of its responsibilities for ESA and Incidental Harassment Authorization (IHA) processes under the Marine Mammal Protection Act. Workshop participants review the results of monitoring efforts to determine the impacts of industry activities on marine mammals in the Beaufort and Chukchi seas and review monitoring plans for the upcoming field season. Required mitigation similar to the lease Stipulation No. 4 - Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources, Stipulation No. 5 - Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvest Activities and conflict avoidance measures defined in an IHA would specify any noise-monitoring program for marine mammals required for ongoing seismic operations in the Chukchi Sea 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, walrus, and bearded seals are present in the vicinity of potential operations and the extent of behavioral effects on these species due to operations; (2) consider the potential scope and extent of impacts that the particular type of operation could have on these species; and (3) address local subsistence hunters' concerns and integrate Inupiat traditional knowledge (USDOJ, MMS, 2003a).

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 reacted to seismic vessels. Other concerns raised by local subsistence hunters that pertain to potential seismic-noise impacts include: (1) developing a plan for minimizing the number of sealifts and making sure they are completed before the fall subsistence whaling season begins; and (2) developing a plan that ensures that local/Native observers are present during seismic activity to monitor for potential noise disturbance to marine mammals (USDOJ, MMS, 2003a). Because the permittee is seeking a Letter of Authorization (LOA) or IHA for incidental take from the NMFS, the monitoring program and review process required under the LOA or IHA generally will satisfy the requirements of Stipulations 4 and 5.

Mitigation similar to the lease Stipulation No. 5 - Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvest Activities is proposed, where seismic survey operations will 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). Mitigation would include submitting a plan to the MMS for activities proposed during the bowhead whale-migration period and consulting with the directly affected subsistence communities, Kaktovik, Nuiqsut, Barrow, Wainwright, and Point Hope, the NSB, the AEW, the ABWC, the EWC, the ISC, and the NC to discuss potential conflicts with the timing and methods of proposed operations and the safeguards or other measures that would be implemented by the operator to prevent unreasonable conflicts.

Through this consultation, the seismic-survey operator would make every reasonable effort, including such mechanisms as drafting a CAA, to ensure that exploration 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 will be included in the exploration plan or permit. In particular, the permittee will 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.

The seismic-survey operator also would include a discussion of multiple or simultaneous operations, such as seismic activities, that can be expected to occur during operations to more accurately assess the potential for any cumulative effects. Communities, individuals, and other entities who were involved in the consultation will be identified in the plan. The MMS shall send a copy of the plan to the directly affected communities, the AEW, the ABWC, the EWC, the ISC, and the NC 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 permittee, the AEW, the ABWC, the EWC, the ISC, the NC, the NSB, and NMFS, or any of the subsistence communities that could be affected directly by the proposed activity may request that the RS assemble a group consisting of representatives from the subsistence communities, the AEW, the ABWC, the EWC, the ISC, the NC, the NSB, NMFS, and the permittee(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.

On request, MMS will assemble this group if MMS 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 permittee shall notify MMS of all concerns expressed by subsistence hunters and of steps taken to address such concerns. Permittee-related use will be restricted when MMS determines it is necessary to prevent unreasonable conflicts with local subsistence-hunting activities. In enforcing this stipulation, MMS will work with other agencies and the public to ensure that potential conflicts are identified and efforts are taken to avoid these conflicts.

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 exploration 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 of adverse effects to subsistence-harvest patterns, sociocultural systems, and Environmental Justice. The above mitigation measures incorporate traditional knowledge and the cooperative efforts between the MMS, the State, the people of the North Slope, and tribal and local governments.

This stipulation has been requested during scoping by the NSB and the AEW. The consultations required by this stipulation ensure that permittees, including contractors, consult and coordinate both the timing of events with subsistence activities. This stipulation has proven to be effective in mitigating prelease—primarily seismic activities—activities through the development of the annual oil/whaler agreement between the AEW and oil companies (USDO, MMS, 2003a).

Stipulations and required mitigation and conflict avoidance measures under MMP authorization as defined by NMFS and FWS should be followed in locations where the subsistence hunt is affected. The MMPA authorization obligates operators to demonstrate no unmitigable adverse impacts on subsistence practices.

CAA's between permittees and the AEWG work toward avoiding unreasonable conflicts and disturbances to hunters and bowhead whales. Similar avoidance measures could be required for the subsistence beluga whale hunt by the ABWC, for the subsistence walrus hunt by the EWC, the subsistence seal hunt by the ISC, and for the subsistence polar bear harvest by the NC. Such CAA's likely would follow protocols similar to those reached annually between permittees and the AEWG for the subsistence bowhead hunt and address industry seismic-vessel activities under provisions of the MMPA. The AEWG prefers to negotiate a CAA with industry on an annual basis using a regional rather than a project-specific approach, so as to address potential impacts from all ongoing projects. With the use of the CAA, Native subsistence-whale hunters generally have been successful in reaching their annual whale "take" quotas. Without conflict avoidance measures in place, potentially significant impacts to the subsistence resources and hunts for bowhead and beluga whales, walrus, bearded seals, and polar bears would result.

To ensure compliance with the MMPA, MMS policy is to make commencement of operations contingent on the operator obtaining from NMFS and FWS an Incidental Take Authorization (ITA), which could be in the form of an IHA or LOA. The ITA's mitigation and monitoring requirements would further ensure that impacts to marine mammals will be negligible and that there will be no unmitigable adverse impact on subsistence uses of marine mammals.

To achieve this standard, the seismic operators have signed a CAA with the AEWG and the affected villages' Whaling Captains Association for seismic surveys in the Chukchi and Beaufort Seas for the 2006 open-water season. The CAA includes provisions for conducting and coordinating seismic surveys with the bowhead whale-hunting season in the Beaufort Sea, describes a dispute-resolution process, and provides emergency assistance to whalers at sea. Implementation of the CAA further ensures that there will not be significant social or economic impacts on the coastal inhabitants of the Chukchi and Beaufort seas by avoiding adverse impacts on subsistence marine mammal-harvest activities.

For MMS-permitted seismic surveys, NMFS- and FWS-sanctioned observers, usually local Alaskan Natives and biologists employed by the monitoring contractor, are onboard survey vessels. These observers stop seismic operations when they observe marine mammals within the safety radius designated by the NMFS. Shut down of the airguns occurs if marine mammals are within this radius because of concern about possible effects on marine mammal hearing sensitivity (USDOI, MMS, 2003a).

IV.C.1.1(2)(b)1) Standard MMS G&G Permit Stipulations. Seismic surveys for prelease geophysical exploration activities in the Beaufort and Chukchi seas would be permitted with existing Alaska OCS exploration stipulations and guidelines and incorporate standard G&G-permit stipulations to ensure that fish, wildlife, and subsistence-harvest resources and practices are not adversely impacted. An inability to effectively perform mitigation measures would result in the suspension of a G&G permit until such time that the protective measures can be successfully performed and demonstrated. The following stipulations are standard for MMS-permitted seismic activities and would be included for all seismic activities proposed in the Chukchi Sea Planning Area:

- No solid or liquid explosives shall be used without specific approval.
- Operations shall be conducted in a manner to ensure that they will not cause pollution, cause undue harm to aquatic life, create hazardous or unsafe conditions, or unreasonably interfere with other uses of the area. Any difficulty encountered with other uses of the area or any conditions that cause undue harm to aquatic life, pollution, or could create a hazardous or unsafe condition as a result of the operations under this permit shall be reported to the Regional Supervisor/Field Operations. Serious or emergency conditions shall be reported without delay.
- Operators must maintain a minimum spacing of 15 mi between the seismic-source vessels for separate operations. The MMS must be notified by means of the weekly report whenever a shut down of operations occurs in order to maintain this minimum distance.
- Permit applicants shall use the lowest sound levels feasible to accomplish their data-collection needs.
- Vessels and aircraft should avoid concentrations or groups of whales. Operators should, at all times, conduct their activities at a maximum distance from such concentrations of whales. Under no circumstances, other than an emergency, should aircraft be operated at an altitude lower than

1,000 ft when within 500 lateral yards of groups of whales. Helicopters may not hover or circle above such areas or within 500 lateral yards of such areas.

- When weather conditions do not allow a 1,000-ft flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 1,000-ft altitude stipulated above. However, when aircraft are operated at altitudes below 1,000 ft because of weather conditions, the operator must avoid known whale-concentration areas and should take precautions to avoid flying directly over or within 500 yards of groups of whales.
- When a vessel is operated near a concentration of whales, the operator must take every precaution to avoid harassment of these animals. Therefore, vessels should reduce speed when within 300 yards of whales and those vessels capable of steering around such groups should do so. Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group.
- Vessel operators should avoid multiple changes in direction and speed when within 300 yards of whales. In addition, operators should check the waters immediately adjacent to a vessel to ensure that no whales will be injured when the vessel's propellers (or screws) are engaged.
- Small boats should not be operated at such a speed as to make collisions with whales likely. When weather conditions require, such as when visibility drops, vessels should adjust speed accordingly to avoid the likelihood of injury to whales.
- When any permittee becomes aware of the potentially harassing effects of operations on endangered whales, or when any permittee is unsure of the best course of action to avoid harassment of endangered whales, every measure to avoid further harassment should be taken until the NMFS is consulted for instructions or directions. However, human safety will take precedence at all times over the guidelines and distances recommended herein for the avoidance of disturbance and harassment of endangered whales.

IV.C.1.l(2)(b)2 Measures to Mitigate Seismic Exposure on Subsistence Resources and Practices.

Specific measures for mitigating seismic survey impacts and implemented in MMSs seismic-survey PEA (USDOl, MMS, 2006a) are discussed below. These measures would be expected to be in-place for pre- and post-lease G & G permits in the Chukchi Sea Planning Area to protect impacts on subsistence resources and practices.

The measures outlined below are based on: (1) MMSs seismic-survey PEA; (2) 2006 IHAs from NMFS for marine geophysical permits in the Beaufort and Chukchi seas; (3) protocols developed at the 2006 Open Water meeting; (4) the 2006 Arctic Regional Biological Opinion developed with NMFS, and (5) 2006 consultation with NMFS and FWS.

Exclusion Zone. A 180/190-dB isopleth-exclusion zone (also called a safety zone) from the seismic-survey-sound source shall be free of marine mammals before the survey can begin and must remain free of mammals during the survey. The purpose of the exclusion zone is to protect marine mammals from Level A harassment (injury/harm). The 180-dB (Level A harassment-injury) applies to cetaceans and the Pacific walrus, and the 190-dB (Level A harassment-injury) applies to pinnipeds other than the Pacific walrus.

Monitoring of the Exclusion Zone. Individuals (marine mammal biologists or trained observers) shall monitor the area around the survey for the presence of marine mammals to maintain a marine mammal-free exclusion zone and monitor for avoidance or take behaviors. Visual observers monitor the exclusion zone to ensure that marine mammals do not enter the exclusion zone for at least 30 minutes prior to ramp up, during the conduct of the survey, or before resuming seismic-survey work after shut down. The NMFS will set specific requirements for the monitoring programs and observers.

Shut Down. The survey shall be suspended until the exclusion zone is free of marine mammals. All observers shall have the authority to, and will, instruct the vessel operators to immediately stop or de-energize the airgun array whenever a marine mammal is seen within the exclusion zone. If the airgun array is completely powered down for any reason during nighttime or poor sighting conditions, it shall not be re-energized until daylight or whenever sighting conditions allow for the exclusion zone to be effectively monitored from the source vessel and/or through other passive acoustic, aerial, or vessel-based monitoring.

Ramp Up. Ramp up is the gradual introduction of sound to deter marine mammals from potentially damaging sound intensities and from approaching the exclusion zone. This technique involves the gradual increase (usually 5-6 dB per 5-minute increment) in emitted sound levels, beginning with firing a single airgun and gradually adding airguns over a period of at least 20-40 minutes, until the desired operating level of the full array is obtained. Ramp-up procedures may begin after observers ensure the absence of marine mammals for at least 30 minutes. Ramp-up procedures shall not be initiated at night or when monitoring the exclusion zone is not possible. A single airgun operating at a minimum source level can be maintained for routine activities, such as making a turn between line transects, for maintenance needs or during periods of impaired visibility (e.g., darkness, fog, high sea states), and does not require a 30-minute clearance of the exclusion zone before the airgun array is again ramped up to full output.

Field Verification. Before conducting the survey, the operator shall verify the radii of the exclusion zones within real-time conditions in the field. This provides for more accurate exclusion-zone radii rather than relying on modeling techniques before entering the field. Field-verification techniques must be consistent with NMFS-approved guidelines and procedures. When moving a seismic-survey operation into a new area, the operator shall verify the new radii of the exclusion zones by applying a sound-propagation series.

Monitoring of the Seismic-Survey Area. Aerial-monitoring surveys or an equivalent monitoring program acceptable to the NMFS may be required.

Reporting Requirements. Reporting requirements, such as the monitoring plans required by FWS for polar bears and walrus prior to the start of seismic activities, provide the regulating agencies with specific information on the monitoring techniques to be implemented and how any observed impacts to marine mammals will be recorded. In addition, operators must report immediately any shut downs due to a marine mammal entering the exclusion zones and provide the regulating agencies with information on the frequency of occurrence and the types and behaviors of marine mammals (if possible to ascertain) entering the exclusion zones.

Temporal/Spatial/Operational Restrictions. Dynamic management approaches to avoid or minimize exposure, such as temporal or spatial limitations are based on marine mammals being present in a particular place or time, or being engaged in a particularly sensitive behavior (such as feeding).

- Seismic survey must not occur in the Chukchi Sea spring lead system before July 1, unless authorized by NMFS, to provide bowhead cow/calf pairs additional protection.
- Seismic-survey activities are not permitted within the Ledyard Bay spectacled eider critical-habitat area.
- Seismic-survey support aircraft must avoid overflights of Ledyard Bay critical-habitat area after July 1; unless aircraft are at an altitude in excess of 1,500 ft or human safety requires deviation (e.g., a medical emergency).

IV.C.1.1(2)(c) Alternative Mitigation for Seismic Surveying. The Selected Alternative (Alternative 6) from the “*Final Programmatic Environmental Assessment, Arctic Ocean Outer Continental Shelf Seismic Surveys – 2006*,” dated June 2006 (USDOI, MMS, 2006a) and the associated suite of mitigation measures are used in the scenario and analysis in this Chukchi Sea Sale 193 EIS. The alternatives considered in the PEA are alternatives to the suite of mitigation measures for seismic surveying assumed for analysis in this EIS.

Depending on the environmental issues and analysis associated with an individual seismic survey or with multiple seismic surveys in the Chukchi Sea Planning Area, some of the mitigations measures described below may be selectively incorporated in Incidental Take Authorizations issued by either NMFS or FWS under section 7 of the ESA or LOAs/IHAs issued under the MMPA for activities under Geological and Geophysical exploration permits issued by MMS. These mitigation measures would function to provide further protection from the possibility for causing adverse environmental impacts in special situations. Any mitigation measures addressing impacts to marine mammals and threatened and endangered species identified in Marine Mammal Protection Act-related incidental take authorizations and/or Endangered Species Act-related reasonable and prudent alternatives would supersede any such related mitigation measures in the relevant MMS permit.

- A 120-dB aerial monitoring zone for bowhead whales in the Chukchi Sea will be established and monitored: (1) once four or more migrating bowhead whale cow/calf pairs are observed at the surface during the vessel research-monitoring program; (2) once Barrow whalers notify NMFS or MMS that bowhead whale cow/calf pairs are passing Barrow; or (3) on September 25, whichever is earliest. Once notified by NMFS or MMS, a daily aerial survey will occur (weather permitting) within the area to be seismically surveyed during the next 24 hours. Whenever four or more migrating bowhead whale cow/calf pairs are observed at the surface during an aerial monitoring program, no seismic surveying shall occur within the 120-dB monitoring zone around the area where the whales were observed by aircraft, until two consecutive surveys (aerial or vessel) indicate they are no longer present within the 120-dB safety zone of seismic-surveying operations.
- A 160-dB vessel monitoring zone for bowhead and gray whales will be established and monitored in the Chukchi Sea during all seismic surveys. Whenever an aggregation of bowhead whales or gray whales (12 or more whales of any age/sex class that appear to be engaged in a nonmigratory, significant biological behavior [e.g., feeding, socializing]) is observed during an aerial or vessel monitoring program within the 160-dB safety zone around the seismic activity, the seismic operation will not commence or will shut down immediately until two consecutive surveys (aerial or vessel) indicate they are no longer present within the 160-dB safety zone of seismic-surveying operations.
- Dedicated aerial and/or vessel surveys, if determined by NMFS to be appropriate and necessary, shall be conducted in the Beaufort and Chukchi seas during the fall bowhead whale-migration period to detect bowhead whale cow/calf pairs and to detect aggregations of feeding bowhead and gray whales. The protocols for these aerial and vessel monitoring programs will be specified in the MMPA authorizations granted by NMFS.
- Survey information, especially information about bowhead whale cow/calf pairs or feeding bowhead or gray whales, shall be provided to NMFS as required in ITA's, and will form the basis for NMFS determining whether additional mitigation measures, if any, will be required over a given time period.
- Seismic-survey and associated support vessels shall observe a 0.5-mile (~800-meter) safety radius around Pacific walrus groups hauled out onto land or ice.
- Aircraft shall be required to maintain a 1,500-foot minimum altitude within 0.5 miles of hauled-out Pacific walruses.
- Seismic-survey operators shall notify MMS, NMFS, and FWS in the event of any loss of cable, streamer, or other equipment that could pose a danger to marine mammals.
- To avoid significant additive and synergistic effects from simultaneous seismic-survey operations that might hinder the migration of bowhead whales, NMFS and MMS will review the seismic-survey plans and may require special restrictions, such as additional temporal or spatial separations.
- Seismic cables and airgun arrays must not be towed in the vicinity of fragile biocenoses, unless MMS determines the proposed operations can be conducted without damage to the fragile biocenoses. Seismic-survey and support vessels shall not anchor in the vicinity of fragile biocenoses (e.g., the Boulder Patch, kelp beds) as identified by MMS or may be discovered by the operator during the course of their operations, unless there is an emergency situation involving human safety and there are no other feasible sites in which to anchor at the time. Permittees must report to MMS any damage to fragile biocenoses as a result of their operations.
- Seismic-survey and support vessels will minimize operations that require high-intensity work lights, especially within the 20-m-bathymetric contour, to minimize the potential for adverse impacts to marine birds.
- High-intensity lights will be turned off in inclement weather when the seismic vessel is not actively conducting surveys to minimize the potential for adverse impacts to marine birds; however, navigation lights, deck lights, and interior lights could remain on for safety.
- All bird-vessel collisions shall be documented. Minimum information will include species, date/time, location, weather, and operational status of the survey vessel when the strike occurred.
- Seismic-survey operators shall adhere to any mitigation measures identified by the FWS to protect polar bears from seismic-survey operations.

Collectively, the above mitigation mechanisms would help protect subsistence-harvest activities from the possible impacts associated with seismic surveys. An operator could propose to conduct seismic-survey activity in an area critical to whaling during the whaling season; however, if this condition did occur,

potential conflict could be mitigated by the cessation of activities during the whale migration. Theoretically, the larger the exclusion zone coupled with shut-down procedures, the greater protection of marine mammals from potential harassment and injury. The more marine mammals are protected, the more subsistence-harvest activities are protected.

IV.C.1.1(3)(d) Transboundary Effects and Mitigation. Because the OSRA models potential spill contact to the Russian Arctic Chukchi Sea coastline, the following discussion on transboundary impacts is included in this analysis.

In July 1997, the Council on Environmental Quality (CEQ) after discussion with various Federal agencies issued a memorandum concerning the applicability of the National Environmental Policy Act (NEPA) to Federal actions that had the potential to produce effects that extended beyond U.S. boundaries and affected another country's environment. The guidance was written to pertain to all federal agency actions, normally subject to NEPA, whether covered by an international agreement or not and to be consistent with long-standing principles of international law.

Courts that have addressed impacts across the United States' borders have assumed that the same rule of law applies in a transboundary context. In *Wilderness Society v. Morton* (463 F.2d 1261 (D.C. Cir. 1972)), the court granted intervenor status to Canadian environmental organizations that were challenging the adequacy of the Trans-Alaska Pipeline EIS. The court granted intervenor status because it found that there was a reasonable possibility that oil spill damage could significantly affect Canadian resources, and that Canadian interests were not adequately represented by other parties in the case.

The CEQ has determined that agencies must include analysis of reasonably foreseeable transboundary effects of proposed actions in their analysis of proposed actions in the United States. Federal Agencies should use the scoping process to identify those actions that may have transboundary environmental effects and determine at that point their information needs (40 CFR 1501.7). Agencies should be particularly alert to actions that may affect migratory species, air quality, watersheds, and other components of the natural ecosystem that cross borders, as well as to interrelated social and economic effects. Should such potential impacts be identified, agencies may rely on available professional sources of information and should contact agencies in the affected country with relevant expertise. Agencies have expressed concern about the availability of information that would be adequate to comply with NEPA standards that have been developed through the CEQ regulations and through judicial decisions. Agencies do have a responsibility to undertake a reasonable search for relevant, current information associated with an identified potential effect. In the context of international agreements, parties may set forth a specific process for obtaining information from the affected country which could then be relied upon in most circumstances to satisfy agencies' responsibility to undertake a reasonable search for information.

It has been customary law since the 1905 Trail Smelter Arbitration that no nation may undertake acts on its territory that will harm the territory of another state (*Trail Smelter Arbitration, U.S. v. Canada*, 3 UN Rep. Int'l Arbit. Awards 1911 (1941)). This rule of customary law has been recognized as binding in Principle 21 of the Stockholm Declaration on the Human Environment and Principle 2 of the 1992 Rio Declaration on Environment and Development. This concept, along with the duty to give notice to others to avoid or avert such harm, is incorporated into numerous treaty obligations undertaken by the U.S. Analysis of transboundary impacts of Federal Agency actions that occur in the U.S. is an appropriate step towards implementing those principles.

The NEPA requires agencies to include analysis of reasonably foreseeable transboundary effects of proposed actions in their analysis of proposed actions in the U.S. Such effects are best identified during the scoping stage, and should be analyzed to the best of the agency's ability using reasonably available information. Such analysis should be included in the EA or EIS prepared for the proposed action (<http://ceq.eh.doe.gov/nepa/regs/transguide.html>).

Because the EIS is the comprehensive environmental analysis document, it also is the correct vehicle to lay out the full spectrum of appropriate mitigation. The NEPA and CEQ specify the identification of all relevant, reasonable mitigation measures that could improve the project, even if they are outside the jurisdiction of the lead agency or the cooperating agencies. And, to ensure that the environmental impacts of a proposed action are fairly assessed, the probability of the mitigation measures being implemented must

also be discussed. Because the Chukchi Sea Sale 193 is a lease sale EIS, the level of mitigation identified in the discussion above would broadly apply to potential subsistence resource and harvest impacts to communities on the Russian Arctic Chukchi Sea coast.

The probability of identified mitigation being implemented outside of MMS and U.S. jurisdiction is unclear at the level of detail required in a lease sale EIS. At the development and production stages, when more specific actions are proposed, the details of mitigation implementation would be developed and would be expected to follow the rule of customary law—that no nation may undertake acts on its territory that will harm the territory of another state—recognized as binding in Principle 21 of the Stockholm Declaration on the Human Environment and Principle 2 of the 1992 Rio Declaration on Environment and Development (<http://ceq.eh.doe.gov/nepa/regs/transguide.html>; (CEQ, 1997).

Conclusion: Effects from Discharges, Seismic Surveys, Other Noise and Disturbance, Small Oil Spills, Large Oil Spills, and Oil Spill Cleanup. For the communities of Barrow, Wainwright, Point Lay, Point Hope, and Kivalina, noise and disturbances periodically could affect subsistence resources. Effects of noise and disturbance on bowheads whales, beluga whales, other marine mammals, terrestrial mammals, freshwater fishes, marine fishes, most birds, and polar bears are expected to range from negligible to local and short term (generally <1 year), and have no regional population effects. No resource or harvest area would become unavailable or undesirable for use because of noise and disturbance, and no resource would experience overall population reductions. Oil-spill cleanup would increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to these species, and alter or extend the normal subsistence hunt.

Because the spring subsistence-whale hunt in the communities of Barrow, Wainwright, Point Hope, and Kivalina would be concluding by the time seismic activities generally begin in the Chukchi Sea, adverse seismic survey effects on the spring whale harvest are not anticipated. The greatest potential disruption of the subsistence whale hunt would be expected in the traditional fall bowhead whale-hunting areas for Barrow, where multiple seismic-survey operations could deflect whales away from traditional hunting areas. The CAA's between the AEW and oil operators conducting one or more seismic-survey operations per open-water season have tended to mitigate disruptions to the fall hunt in these communities, but the magnitude of three or more concurrent seismic surveys would test the ability of survey operators and whalers to coordinate their efforts to prevent disruptions to the hunt.

Barrow's fall bowhead whale hunt would be particularly vulnerable. Noise effects from multiple seismic surveys to the west in the Chukchi Sea and to the east in the Beaufort Sea potentially could cause migrating whales to deflect farther out to sea, forcing whalers to travel farther—increasing the effort and danger of the hunt—and increasing the likelihood of whale-meat spoilage, as the whales would have to be towed from greater distances. Barrow's fall hunt is particularly important, as it is the time when the Barrow whaling effort can "make up" for any whales not taken by other Chukchi Sea and Beaufort Sea whaling communities. These communities give their remaining whale strikes to Barrow, hoping that Barrow whaling crews will successfully harvest a whale and then share the meat back with the donating community. This practice puts a greater emphasis on the Barrow fall hunt. Additionally, changing spring-lead conditions—ice becoming thinner in recent years due to arctic warming—has made the spring hunt more problematic and makes the fall hunt even more pivotal in the annual whale harvest for all communities in the region. Thus, any disruption of the Barrow bowhead whale harvest could have significant effects on regional subsistence resources and harvest practices (USDO, MMS 1987c; Brower, 2005).

Beluga whales, when in confined areas such as spring leads or lagoons, are potentially sensitive to noise. If boat traffic moved north and south along the coast very near Kasegaluk Lagoon and interfered with beluga whale or spotted seal movements to and from the lagoon, such disturbance could compromise the Point Lay subsistence effort. Icebreaking activities have been demonstrated to disturb beluga whales at much greater distances than bowhead whales. In summer, if vital lagoons and bays used by beluga whales and spotted seals, and a walrus haulout site near Cape Lisburne are not avoided by seismic-survey vessels, local harvests could be compromised. Any displacement of the local movements of whales, seals, and walrus by seismic-survey noise could disturb the subsistence-harvest of a particular species. If multiple surveys were done in close proximity to each other, seismic survey noise could displace fish species, making them more difficult to harvest.

With the potential of up to six seismic surveys being conducted in the open-water season in the Chukchi Sea, the additive and synergistic noise impacts produced by more than a single seismic survey would indicate an acoustic environment where clearly much more than a single sound event and a “low level” of activity would be occurring; thus, the approach of considering seismic-survey noise as a short-term and local disturbance phenomenon to these species may be considered too narrow. Given the level of potential seismic-survey activity described in the scenario and past assessments of species and resource effects discussed above, whales, seals, walrus, and polar bears might be displaced and their availability affected for an entire harvest season, potentially causing significant impacts. In-place protective mitigation for Sale 193, stipulated measures for seismic-survey permits, and mitigation accompanying NMFS IHA authorizations ensures that CAA’s will be in place and that acceptable levels of whale monitoring will occur to ensure that no unmitigable adverse effects from seismic survey activity to subsistence-harvest patterns, resources, or practices would occur.

Overall, oil spills could affect subsistence resources periodically in the communities of Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and communities on the Russian Arctic Chukchi Sea coast. In the 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 and beluga whales and other marine mammals could be rendered unavailable for use. Tainting concerns in communities nearest the spill event could seriously curtail traditional practices for harvesting, sharing, and processing bowhead and beluga whales and threaten a pivotal element of Inupiat culture.

There also is concern that the IWC, 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. Tainting concerns also would apply to beluga whales, seals, walrus, caribou, fishes, birds, and polar bears. Additionally, effects from a large oil spill likely would produce potential short-term but serious adverse effects to certain waterfowl 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.1.m. Sociocultural Systems.

This section describes the potential effects on sociocultural systems from activities associated with the Proposed Action as described in the scenario. Sociocultural systems are described in Section III.C.3, with reference to social organization, cultural values, and institutional organization.

As shown in Table IV.C-2, the **social organization** is made up of households, families, and wider networks of kinship and friends that, in turn, are embedded in groups that are responsible for acquiring, distributing, and consuming subsistence resources. In many ways, this element describes the nongovernmental characteristics of the community. Potential effects to social organization could be realized if project-related activities alter employment or income characteristics of the area, change the demographics of the area, result in changes to the workforce, or otherwise affect the social well-being of area residents.

Cultural values emphasize the Inupiat’s close relationship with natural resources, with particular focus on kinship, maintenance of the community, cooperation, and sharing. Subsistence is a central activity that

embodies these values, with bowhead whale hunting the paramount subsistence activity. Potential effects to cultural values could be realized if project-related activities alter subsistence harvest, known archaeological or cultural sites, and cultural continuity. In some respects, this element overlaps with social organization.

Institutional organization encompasses the structure and functions of borough, city, and tribal government, and related formal organizations such as the Alaska Native Regional and various village for-profit and not-for-profit corporations, and nongovernmental organizations. In many ways, this element describes the governmental and related functions of the community. Potential effects to institutional organization could be realized if project-related activities affect how institutions are structured or how they function to provide services and foster community stability.

IV.C.1.m(1) Conclusions. In characterizing the potential adverse effects from OCS activities, we look at the magnitude and duration of disruption, with “significant” effects equated to conditions described as a chronic disruption of social organization, cultural values, and institutional organization for a period two to five years with a tendency toward displacement of existing social patterns.

As outlined below, the following conclusions may be drawn from the detailed analysis:

- Effects from the anticipated 3D seismic surveys and exploration should not exceed the significance threshold. See Section IV.B.1.m(2) and (3) and Table IV.C-2.
- At the regional level (NSB), effects from development, production, and decommissioning should not exceed the significance threshold.
- At the local level, (Wainwright in the scenario), effects from routine development could exceed the significance threshold. See Section IV.B.1.m(4)(a) and Table IV.C-2.
- Effects from a large oil spill could exceed the significance threshold. See Section IV.C.1.m(4)(b).
- Mitigation measures should prove effective in ameliorating many of the effects of OCS activities. Social systems will successfully respond and adapt to the change brought about by the introduction of these activities. If development and production occur, this accommodation response fundamentally represents circumstances that exceed the significance threshold.

For 3D/2D seismic surveys and exploration, which are projected to occur for at least 3 years each, effects to sociocultural systems are expected to be minimal. Effects to social well being (social systems) will be noticeable because of concern over deflection of the bowhead whale due to seismic survey activities and the attendant effects on subsistence harvest. These concerns may translate into greater activity as various institutions seek to influence the decision making process (institutional organization). However, the combination of effects would not be sufficient to displace existing social patterns. If the deflection actually occurs, effects could be significant.

For routine activities from exploration, development and production, and decommissioning (abandonment), effects to sociocultural systems will cause noticeable disruption to sociocultural systems during development, a period that would last more than 5 years. However, the combination of effects would not be sufficient to displace existing social patterns at the regional level.

On the local level, Wainwright may experience significant effects. Noticeable disruption most likely would result during development from the placement of onshore infrastructure, with the most prominent effect being the change in land use that comes about by introduction of industrialization. However, Wainwright would experience other effects to social organization, cultural values, and institutional organization for a period exceeding 2-5 years. Collectively, these other effects represent a chronic disruption. Given the resiliency of social systems (that is, many aspects of social organization, cultural values, and institutional organization will not be affected or will continue unchanged) and their ability to adapt (that is, new capacity to address the effects will emerge), the chronic disruption could be successfully accommodated. However, the social patterns that emerge will be markedly different from the patterns that preceded development. In other words, displacement will have occurred.

For large oil spills, noticeable disruption in excess of 2 years could occur from the oil spill and cleanup activities. The effects of this disruption would last beyond the period of cleanup and would represent a

chronic disruption of social organization, cultural values, and institutional organization. The effects would have a tendency to displace existing social patterns.

IV.C.1.m(2) Effects from 3D/2D Seismic Surveys. The potential effects of a seismic survey are described and discussed at length in the seismic-survey PEA, which found that effects on the sociocultural systems of the communities of Barrow, Atkasuk, Wainwright, Point Lay, and Point Hope might result from seismic-exploration activities (USDOI, MMS, 2006a). Because the seismic-survey activities are vessel based, stresses to local village infrastructure, health care, and emergency response systems are expected to be minimal; therefore, social systems in these communities would experience little direct disturbance from the staging of personnel and equipment for seismic exploration.

However, as the assessment discussed, the possible long-term deflection of whale-migration routes or increased skittishness of whales due to seismic-survey activities in the Beaufort and Chukchi seas might make subsistence harvests more difficult, dangerous, and expensive. To date, no long-term deflections of bowheads have been demonstrated; however, seismic activity of the magnitude discussed in the scenario for the 2006 surveys and those described in the Sale 193 scenario has not been approached since the 1980's.

The PEA identified the more predominant issue associated with potential impacts on sociocultural systems as the potential disruption of seismic-survey noise on subsistence-harvest patterns, particularly those involving the bowhead whale, which is a pivotal species to the Inupiat culture. Such disruptions could impact sharing networks, subsistence task groups, and crew structures as well as cause disruptions of the central Inupiat cultural value: subsistence as a way of life. Over time, these disruptions also could cause a breakdown in family ties, the community's sense of well-being, and could damage sharing linkages with other communities. Displacement of ongoing sociocultural systems by seriously curtailing community activities and traditional practices for harvesting, sharing, and processing subsistence resources might occur. A more detailed description of these effects is provided under effects from a large oil spill, Section IV.B.1.m(4)(b).

IV.C.1.m(3). Effects from Exploration. As shown on Table IV.C-2, many of the effects from exploration are similar to those effects from seismic surveys, because the most of the activities based on largely self-supporting vessels, stresses to local village infrastructure, health care, and emergency response systems are expected to be minimal; therefore, social systems in these communities would experience little direct disturbance from the staging of personnel and equipment for exploration. During the exploration phase, Barrow and Wainwright would be used as air-support bases for offshore operations. Personnel and freight would be transferred at either location for the helicopter flight to the offshore location. There could be between one and three flight a day, depending on the level of offshore activity. The existing facilities at Barrow and Wainwright appear sufficient to meet these needs. Vessels used in support of exploration activities staging out of Barrow would have to anchor offshore, as Barrow has no seaport.

IV.C.1.m(4) Effects from Development and Production. If exploration leads to discovery, the scenario anticipates construction of a shore base in the vicinity of Wainwright to support development and production activities and that a construction of a pipeline connecting the landfall of the offshore pipeline to the TAPS. This section discusses the potential routine effects from those activities, effects from oil spills, and effects from an unanticipated large disruption to subsistence-harvest activities.

IV.C.1.m(4)(a) Effects from Routine Activities. The physical presence of the shore base and pipeline infrastructure represents the initial industrialization of the area and represents a long-term and significant change in land use patterns. However, the attendant positive and adverse sociocultural effects that could result from the construction and operation of the supply base and pipeline are for the most part negligible at the Borough level, although local effects could be more pronounced. For example, this infrastructure represents a continuation of the dominant industrial/commercial activity on the Borough level while it represents a substantial change in the industrial/commercial activity and diversity of the Wainwright area.

The shore base would serve as an enclave to house project-related workers, who would largely travel out of the area at shift change. As noted in Table IV.C-2, development and production activities would have little effect on the demographics and workforce changes of the communities on the North Slope. However, shore-base employment could have an effect on the demographics of nearby Wainwright. The city's

population decline between 1998 and 2003 is attributed to the completion of several large capital improvement projects and the corresponding decline in jobs available in the community. The unemployment rate in Wainwright was estimated at approximately 19% in the 2003 Census, which is higher than the rates for the state or nation for a similar timeframe. Wainwright's unemployment rates for Inupiat residents were higher than for non-Inupiat residents (URS Corporation, 2005). Construction would create business opportunities for Native corporations. Local employment would stabilize population and density and slow the rate of decline and increase the stability of the community, in the short term. The end of shore-base construction could cause an exodus of workers similar to that experienced by the community with the completion of the capital improvement projects. However, as noted elsewhere, petroleum activities generally have not translated into employment opportunities for the area's Native residents. Generally, employment opportunities are viewed positively by NSB residents. Moreover, wage employment can facilitate subsistence harvest activities (URS Corporation, 2005; Martin, 2005). However, if industrial development and employment conflicts with subsistence harvest activities and related networks, these opportunities could cause disruption of sociocultural systems and be associated with declines in perception of economic and social well being (Kruse, 1984) and individual satisfaction with subsistence (Martin, 2005).

Some local services could be affected by the proximity of operations to Wainwright. For example, under the scenario, until the airfield at the shorebase is complete, transportation to and from the enclave would utilize the airport at Barrow and Wainwright. The importation of alcohol is prohibited in Wainwright. Enforcement of this prohibition by public safety officers at originating airports in Alaska (Anchorage, Fairbanks, and Barrow, for example) and at Wainwright would increase with the frequency of flights in proportion to the rate that this surveillance is currently conducted. As enclaves generally are self-sufficient, establishment of the shore base should create little demand for government services such as waste disposal, power and communication, housing, health care, and education. Air and marine operations gradually would shift to the shore base, with airports in Barrow and Wainwright providing alternatives in case of emergencies and allow the shift from existing to new transportation infrastructure to occur gradually without overtaxing existing facilities.

Because of the use of enclaves, little immigration or outflow of residential, non-Native workers for Wainwright is anticipated. Table IV.C-1 projects that a total of 30 and 11 direct, indirect, and induced jobs would be created across the NSB by the development activities and production activities, respectively, envisioned by the scenario. Sufficient housing units appear to be available to handle what influx may occur. The community had 179 housing units, with 148 occupied, leaving 31 vacant (URS Corporation, 2005). We anticipate little disruption from the presence of the new residents. Conflicts over subsistence resources are not expected as non-Native households of NSB communities claim to use none or very little subsistence resources (Shepro, Maas, and Calaway, 2003). As such, an influx of new residents from development and production related employment would be expected to have little direct and indirect consequences to sociocultural systems.

Wainwright became accustomed to housing even larger nonresident labor forces because of previous capital improvement program employment. The proximity of the shore base to Wainwright may bring non-resident workers at the enclave and others into greater contact with area residents. Positive and negative effects may result from this interaction, as was noted by other NSB communities proximate to oil and gas activities, (Kaktovik Impact Project, 2003; URS Corporation, 2005; Nuiqsut Community Profile; USDOJ, BLM, 2004). Precise effects of this interaction are difficult to quantify. Communities in California that have OCS-related onshore infrastructure established impact monitoring and mitigation programs with industry. These programs ascertained the effects and recovered costs for services provided by local government (USDOJ, MMS, 2000b). These monitoring and mitigation programs and other measures have facilitated project approval when there is uncertainty over the cause and effect of project-related impacts (Woolley and Lima, 2003).

Construction and operation of the shore base—a new use for the Chukchi Sea coast—would require planning, zoning, and permitting actions that routinely are undertaken by Borough government departments for similar oil and gas infrastructure. The Borough government makes a distinction between onshore oil development, which it generally supports, and offshore development, which it generally opposes. This opposition may have an effect on the policy-formulation process but is not expected to affect land use planning and permitting processes. Other local governments and nongovernmental organizations involved

in the planning process would incur the marginal expense of that participation. These efforts may represent new and substantial challenges to the financial and administrative capacity of organizations as petroleum-related industrialization represents a qualitatively new activity to these organizations. Past analyses have noted that stress to organizations and individuals may result from a lack of resources to mobilize for advocacy, lack of time to participate in the decisionmaking process, the repetitive nature of the decisionmaking process, and the multiplicity of processes that require participation and response (USDOJ, MMS, 2006a). Because of its proximity to onshore infrastructure, these effects will be most pronounced for Wainwright.

Section IV.C.1.1, Subsistence Resources and Section IV.C1.n, Archaeological Resources describe the potential effects on traditional-use areas and archaeological sites as a result of development and construction activities. Essentially, potential effects include disturbance of traditional use and archaeological sites, such as hunting, fishing, and whaling camps, by construction and the increased possibility for vandalism. Any effects to these resources would have a corresponding and proportional effect on cultural values.

Precise effects from decommissioning of the shore base and pipeline are difficult to forecast, as this activity will occur at the end of the lifecycle of a long-term project. However, effects in general are expected to be caused by removal and restoration activities and be very similar to those forecast for construction of the facilities described above.

IV.C.1.m(4)(b) Effects from a Large Oil Spill. 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, and overall effects from these sources could be 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, and could further displace these systems, although cleanup activities alone are not sufficient to cause displacement. 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.

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.

IV.C.1.m(4)(b)1 Pattern of Sociocultural Effects from a Large Oil Spill. Disruption of subsistence-harvest resources, such as that created by a large oil spill, would have predictable and significant consequences and would affect all aspects of sociocultural resources—social organization, cultural values, and institutional organization (Luton, 1985).

The primary effect would be the depletion each Native family's stored foods and harvesting of less-preferred resources. However, concerns over tainting would create a reluctance to consume suspect resources. The harvest of less-preferred resources is more time, labor, and equipment intensive.

Social organization effects would be very pronounced. Social well-being would be affected as risk, safety, and health concerns would increase as the work of harvest became more intensive increasing the likelihood of equipment breakdowns and accidents among harvesters. Increased demands would be placed on the networks in which each household participates, as available resources were redistributed according to need. If scarcity continues, greater requests would be made, first to nearby communities and then to those beyond (Fairbanks, Anchorage, and other cities inside and outside Alaska). These requests, in turn, would accelerate the depletion of the resources of the contributing networks. Employment and income effects could be realized as cash was expended to maintain equipment and purchase food at local stores to make up for the shortfall in harvested foods. Lines of credit would be stretched. Workforce changes and demographic changes could occur with consolidation of households to save money, placement of dependents with relatives beyond the village, and outmigration of wage earners in search of employment further depleting the pool of available subsistence producers and affecting the structure of households and reducing the stability of families and communities.

Stress to subsistence and sharing could affect the very central core values of the Inupiat culture. The inability of the community's leaders—the subsistence providers—to fulfill their role would have negative effects on community stability. Over time, if knowledge holders or recipients are removed from the community, spiritual teaching and knowledge transfer that takes place as part of the hunt would be diminished. The loss of equipment and property used in subsistence harvest and foreclosure of use of the materials in objects of cultural expression and trade, an important source of supplemental income to approximately one in five households, could also result.

Institutional organizations would be affected as requests for temporary assistance from various public and private institutions would likely increase. As cash was diverted to meet the increased costs of food, other expenses such as utilities might go unpaid. Demands for corrective actions by organizational institutions are likely to increase, with institutions working cooperatively to find solutions to the problem. However, if corrective action did not sufficiently address the effects, legal action and other forms of social action could increase eroding cooperation between institutions.

IV.C.1.m(4)(b)2) Effects from Oil Spill Cleanup Activities. If a large oil spill 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 bbl 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 (Impact Assessment, Inc., 1998).

IV.C.1.m(5) Effectiveness of Mitigation Measures. The mitigation measures for Sale 193 have been patterned on those that have been shown to be effective for OCS activities in the Beaufort Sea. These measures developed from activities starting onshore at Prudhoe Bay which expanded from that location.

These measures should work as well for OCS activities in the Chukchi Sea. However, to the extent that these activities are “new” to the area, we should expect the same process of evolution and adaptation for Chukchi Sea communities as was experienced by Beaufort Sea communities. If development and production occurs, this accommodation represents a chronic disruption of existing system for a period of more than two years with a tendency to displace existing social patterns.

IV.C.1.m.(5)(a) 3D Seismic Surveys. Seismic surveys for geophysical exploration activities would be permitted with existing Alaska OCS exploration stipulations and guidelines and additional specific protective measures. An inability to effectively perform mitigation measures will result in the suspension of a G&G permit until such time that the protective measures can be successfully performed and demonstrated. Avoidance planning, stipulations and required mitigation, and conflict avoidance measures under MMPA authorization are defined by NMFS and FWS would serve collectively to mitigate disturbance effects on Native lifestyles and subsistence practices and likely would mitigate any consequent impacts on sociocultural systems. To ensure compliance with the MMPA, MMS also is requiring seismic-survey operators to obtain from NMFS and FWS an ITA, which could be in the form of an IHA or LOA, before commencing MMS-permitted seismic-survey activities. The ITA’s mitigation and monitoring requirements would further ensure that impacts to marine mammals will be negligible, and that there will be no unmitigable adverse impact on subsistence uses of marine mammals. Finally, the seismic operators are encouraged to negotiate a CAA with the AEWC and the affected villages’ Whaling Captains Association. Past CAA’s have included a prohibition on conducting seismic surveys during the bowhead whale-hunting season, described a dispute-resolution process, and provided emergency assistance to whalers at sea. Implementation of the CAA further ensures that there will not be significant social or economic impacts on the coastal inhabitants of the Chukchi Sea by avoiding an adverse impact on subsistence marine mammal-harvest activities.

IV.C.1.m.(5)(b) Sale 193 Stipulations and ITL’s. Stipulation No. 2, Orientation Program, could contribute to the moderation of potential effects to cultural values that may result from project-related activities. By providing information about Inupiat culture and increasing sensitivity to community values, customs, and lifestyles, and reviewing the need for avoidance of conflicts with subsistence, and emphasizing the importance of not disturbing archaeological sites and other traditional use areas the stipulation could reduce effects from routine operations, although its effectiveness would be difficult to ascertain.

Stipulation No. 4, Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources, should serve to strengthen inter-organizational cooperation through coordination of activities and sharing of information with government and nongovernment organizations, especially the AEWC. By providing mitigation for subsistence harvest activity, the stipulation will reduce the attendant sociocultural effects.

Stipulation No. 5, Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvesting Activities, has been proven effective in reducing conflict to subsistence harvest activities thereby reducing the attendant social organization, cultural values, and institutional organization characteristics. In addition, provisions in past agreements regarding assistance in the event of an accident serve to reduce risk and increase the safety of whaling crews. Through the consultation fostered by this stipulation, inter-organization communication has been strengthened.

The ITL No. 1, Information on Community Participation in Operations Planning, should prove effective in reducing sociocultural effects to the extent that the lessees implement the advisory and the community participates in the planning activities. Issues explored in this participation could include perceived effects from the proximity of onshore infrastructure to the affected community.

IV.C.1.m.(5)(c) Other Mitigation. According to table IV.C-1, 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 NSB 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 NSB 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 NSB residents. In particular, hiring and employment practices which value and facilitate continued participation in the subsistence seasonal round are encouraged by the NSB and local 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 (e.g., Arctic Slope Regional Corporation [ASRC]), 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 ASRC and its oil-field subsidiaries and is coordinated with the NSB and the NSB 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, 1998). Iligsavik College in Barrow was specifically established to train young Natives for work in the oil fields.

IV.C.1.n. Archaeological Resources.

Activities associated with leases that affect the seafloor have the potential to disturb prehistoric archaeological resources in water depths of less than 60 m. This is based on past sea-level history only. No prehistoric resources are expected in some areas of the shelf in water depths less than 60 m where (1) there are no Quaternary sediments, and (2) where extensive ice gouging has reworked the Quaternary section. However, these are not well defined and will have to be determined on a case-by-case basis. High-resolution seismic data from site-clearance surveys will reveal these features and sediment thickness (see Map 7, Archaeology Blocks and General Location of Shipwrecks in the Sale 193 Area). The likelihood of historic resources such as shipwrecks, abandoned relics of historic importance, or submerged airplanes, is determined by historical records and their areas are tentatively identified in the Alaska Shipwreck database (See Table III.C.18, Shipwrecks in the Chukchi Sea Planning Area). There may be other occurrences of historic resources, and these will be determined during survey work. Activities that have the potential to disturb offshore archaeological resources include: (1) anchoring; (2) pipeline trenching; (3) excavating well cellars; (4) emplacement of bottom-founded platforms; and (5) use of bottom cables for seismic data collection.

IV.C.1.n(1) Effects from Exploration.

IV.C.1.n(1)(a) Effects from Routine Operations – Disturbance. Physical disturbance of resources could damage or destroy buildings, shipwrecks, sites, or artifacts, or cause a loss of site context with resulting loss of archaeological 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 <60 m in areas not identified as having high-density ice gouging, has the potential to affect prehistoric and historic shipwreck archaeological resources. Any activity that disturbs the seafloor in water >50 m has the potential to affect historic resources such as shipwrecks, abandoned relics of historical importance, or airplanes. It is not only the intensity of ice-gouging evident at the seafloor, but the depth to which sediments have been reworked by ice gouging that is important. If the Holocene sediments are thick enough in an area (and this would be especially true where Holocene sediments are infilling a relict Pleistocene channel feature) prehistoric sites may have survived intact, regardless of the severity of ice-gouging at the seafloor. This can only be determined after a high-resolution seismic survey is conducted of the area. 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 that could damage previously unidentified onshore archaeological resources include:

- installation of rigs for extended-reach drilling;
- construction of gravel pads;

- year-round roads;
- pipeline construction and installation;
- gravel mining; and
- oil-spill-cleanup activities in the event that a large spill occurs.

Activities that have the potential to disturb offshore archaeological resources include:

- anchoring;
- pipeline trenching;
- excavating of well cellars;
- emplacement of bottom-founded platforms; and
- use of ocean bottom cables for seismic data collection.

Pipeline construction in the area of Peard Bay and seaward in a northerly direction could disturb shipwreck resources where historic accounts have identified five whaling barks wrecked since 1871, two steam whalers wrecked in 1897, and another steam freighter wrecked in 1924.

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-m in diameter), which extends from the surface down to depths of 75-100 m, 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.
- Emplacement of bottom-founded platforms may compress Holocene sediments, releasing water and possibly biogenic gas, which could disturb the host and overlying strata. Drillship anchors may disturb host or overlying sediment.

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 m. However, geophysical and archaeological surveys would identify any such resource before the platform is moved and the resource would be avoided or potential effects will be mitigated.

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 well cellar 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 (DEW) 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.1.n(1)(b) Effects from 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.1.n(2) Effects from Development and Production.

IV.C.1.n(2)(a) Effects from Routine Operations – Disturbance. 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, more concentrated, and last longer. In addition, development would require the construction of pipelines offshore and onshore.

The placement of a bottom-founded production platform may compresses Holocene sediments, releasing water and possibly biogenic gas, which could disturb the host and overlying strata, including potential prehistoric archaeological resources.

We assume that onshore pipelines would be elevated with vertical support members (pilings). These probably would disturb <2 ft² (0.2 m²) of soil to a depth of several tens of feet (tens of meters), but could penetrate soil horizons of potential archaeological significance. 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 containing site deposits, 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 production 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 areas where water depths are <60 m and that have sufficient sediment cover to have protected sites from the effects of marine erosion and ice gouging. Prehistoric archaeological resources are not expected in areas where water depths exceed 60 m, because these areas of the continental shelf would have become submerged by rising sea level prior to 13,000 years Before Present. 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.1.n(2)(b) Effects from Small Oil Spills. The potential effects on archaeological resources from small oil spills are the same as for the exploration phase (Sec. IV.C.1.n(1)(b)).

IV.C.1.n(2)(c) Effects from a Large Oil Spill. The effects on archaeological resources from large oil spills would be the same as described in the section above on small oil spills (Sec. 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 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 250.211; 30 CFR 250.241; 30 CFR 250.1007(a)(5); and 30 CFR 250.1010(c)); ITL No. 16, Archaeological and Geological Hazards Reports and Surveys (Sec. II.B.3.C(3)); MMS NTL No. 05-A03, Archaeological Survey and Evaluation for Exploration and Development Activities, 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.1.o. Land Use Plans and Coastal Management Programs.

All of the alternatives, except Alternative II (No Lease Sale), assume similar levels of activity for purposes of land use planning and review with the Alaska Coastal Management Program (ACMP). Therefore, the effects to land use plans and coastal management programs are essentially the same for each alternative. The analysis that follows focuses on the effects to the plans and programs, and is common to all development alternatives.

Onshore activities and some offshore activities ensuing from an OCS oil and gas lease sale are subject to the NSB Comprehensive Plan and Land Management Regulations and the ACMP, including the

enforceable policies of the NSB Coastal Management Plan (NSBCMP). The NSB's Land Management Regulations (LMR's) are applied to all developments occurring on private and State-owned lands. These developments include portions of road/pipeline corridors, including offshore portions within the NSB boundary.

All development that occurs within the State's coastal zone management boundaries or Federal activities affecting the uses or resources of the coastal zone, including activities described in EP's and DPP's, will be subject to the Statewide ACMP standards and the enforceable policies of the NSBCMP. The policies of the LMR's and the ACMP are examined for potential conflicts with the potential effects identified in Section V.C.1.

IV.C.1.o(1) North Slope Borough Comprehensive Plan and Land Management Regulations. The NSB Comprehensive Plan works in concert with the Borough's Title 19 LMR's, CMP, and Comprehensive Transportation Plan. The NSBCMP and LMR's are being revised. The Comprehensive Transportation Plan was adopted in 2005 and is an element of the Comprehensive Plan.

The LMR's establish five zoning districts within the Borough: Village, Barrow, Conservation, Resource Development, and Transportation Corridor. All areas within the NSB are in the Conservation District unless they are specifically designated within the limited boundaries of a village or Barrow, a unitized oil field within the Resource Development District, or within the TAPS corridor. The LMR's categorize uses as: (1) those that can be administratively approved without public review; (2) those that require a development permit and public review before they can be administratively approved; and (3) those considered to be conditional development that must be approved by the Planning Commission.

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.

The LMR's establish policies applicable to development and uses within the Borough. These policies are categorized as: Village Policies, Economic Development Policies, Offshore Development Policies, Transportation Corridor Policies, and Coastal Management and Areawide Policies. All policies address oil and gas leasing activities, both onshore and offshore. The enforceable policies of the NSBCMP are incorporated within the Coastal Management and Areawide Policies.

The primary difference between Coastal Management and Areawide Policies of the LMR's and the enforceable policies of the NSBCMP would be the process used for implementation and the geographic areas covered. The LMR's apply to all lands within the NSB that are not in Federal ownership. The ACMP covers only activities within the coastal zone, although any Federal activity regardless of its location that affects the land and water uses of the coastal zone would be subject to the ACMP standards and to the enforceable policies of a district's coastal management plan. Also, activities proposed under an OCS plan would require a consistency certification under the ACMP. Consequently, development assumed to occur following a lease sale would be subject to the ACMP policies, including the NSBCMP, and depending on location to the borough's LMR's. To avoid a redundant analysis, potential conflicts with the Coastal Management and Areawide Policies of the LMR's are included within the analysis of the ACMP rather than here.

Policies considered in this section are those under 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 NSB communities would not be applicable.

Economic Development policies afford special consideration for projects during land use reviews that have features the NSB considers beneficial impacts (NSB Municipal Code [NSBMC] 19.70.030(A) through (G)). Economic Development policies foster hiring practices favorable to NSB 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 offshore areas within the NSB. 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 AEW. This policy will be especially applicable during development.

The last category of policies covers the Transportation Corridor. It is assumed that if new 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 NSB LMR's. 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 NSB that have some features comparable to those for the pipeline corridors, the NSB 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.1.o(2) Alaska Coastal Management Program (ACMP). Section 307(c)(3)(B) of the Federal Coastal Zone Management Act (CZMA), 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 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 mi 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. 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.

The State of Alaska recently amended its coastal management program and adopted new regulations under Title 11, AAC, Chapters 110, 112, and 114. The State regulations became effective on October 29, 2004. On December 29, 2005, the U.S. Department of Commerce (USDOC), National Oceanic and Atmospheric Administration, Office of Ocean and Coastal Resource Management (OCRM), completed its review and approved the amendments to the ACMP, finding that the amended ACMP meets all requirements of the CZMA.

On January 3, 2006, the commissioner of the Alaska Department of Natural Resources (ADNR) certified to the lieutenant governor under 11 AAC 112.010 that the USDOC approved the Alaska statewide standards of 11 AAC 112.200 through 11 AAC 112.990. Accordingly, the standards of 11 AAC 112.200 through 11 AAC 112.990 apply to consistency determinations initiated on or after January 4, 2006.

Under the amended ACMP, all coastal districts must revise their local plans to conform to the new Statewide standards. A district's existing coastal management program, including its enforceable policies, remains in effect until March 1, 2007, unless the ADNR disapproves or modifies all or part of the program before March 1, 2007. However, any existing district enforceable policy that duplicates, restates, or incorporates by reference a statute or regulation of a Federal or State agency or addresses any matter regulated by the Alaska Department of Environmental Conservation (ADEC) are now repealed and declared null and void under State law.

This analysis in this document is not a consistency determination pursuant to the CZMA 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.

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. The currently policies of the NSBCMP are assessed in conjunction with the most closely associated Statewide standard. As noted above, however, the NSB is required to revise its district plan to conform to the new Statewide standards of the Alaska program, and some of the NSBCMP policies now may be null and void under State law.

Because the NSBCMP policies have been incorporated into the NSB's LMR's, the corresponding regulatory policy number is listed following that of the NSBCMP policy.

IV.C.1.o(2)(a) Coastal Development (11 AAC 112.200). The Statewide coastal development standard gives priority to development that is water-dependent or water-related and uses that may be neither of these but for which there is no feasible or prudent inland alternative to meet the public need for the use or activity. The intent of the policy is to ensure that onshore development and activities that could be placed inland do not displace activities dependent upon coastal locations. For purposes of implementing this standard, coastal water is defined under 11 AAC 112.990(6) as those waters, adjacent to the shoreline, that contain a measurable quantity or percentage of sea water, including sounds, bays, lagoons, ponds, estuaries and tidally influenced rivers.

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 (11 AAC 112.200(c)). All offshore and much of the onshore development hypothesized in the scenarios would be subject to the Corps' regulations. Hypothetical developments along the Chukchi Sea coast that would require the Corps' permits to 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' 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.1.0(2)(b) Natural Hazard Areas (11 AAC 112.210). This Statewide standard allows the ADNR and coastal districts to designate natural hazard areas within the coastal area. Natural hazards are defined under 11 AAC 112.990(15) as natural processes or adverse conditions that present a threat to life or property in the coastal areas from flooding, earthquakes, active faults, tsunamis, landslides, volcanoes, storm surges, ice formations, snow avalanches, erosion, and beach processes. Natural hazards may also include other natural processes or adverse conditions designated by the ADNR or by a district in a district plan.

There are currently no designated natural hazard areas on the North Slope or in the Beaufort Sea. The ADNR, however, may designate natural hazards in a department planning effort or within the context of a consistency review under 11 AAC 110. Natural hazards would be considered during review of individual projects when site-specific information is available. Development plans must describe natural hazards in the area, identify site-specific factors that might increase risks, and propose appropriate measures to reduce those risks.

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 NSBCMP 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” (NSBCMP 2.4.6(c), NSBMC 19.70.050.L.3). Some of the onshore development (e.g., pipelines) may be located in wetlands, in floodplains subject to a 50-year recurrence level, and in geologic-hazard areas identified on maps in the NSBCMP Resource Atlas (NSBCMP 2.4.5.1(j), NSBMC 19.70.050.J.3(j)). 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 (NSBCMP 2.4.6(f), 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 NSB policies related to natural hazards.

IV.C.1.o(2)(c) Coastal access (11 AAC 112.220). This Statewide standard requires projects maintain and, where appropriate, increase public access to, from, and along coastal water. The NSBCMP requires that development not preclude reasonable subsistence access to subsistence resources (NSBCMP 2.4.3(d), NSBMC 19.70.050.D.1). Most activity associated with Chukchi oil and gas development would be offshore and would not affect public access to coastal water. During construction of a pipeline landfall, coastal access could be disturbed in the immediate vicinity of the construction site, but this disruption would be short term and localized.

No conflicts with the Statewide standard or with the NSB policies related to coastal access are anticipated.

IV.C.1.o(2)(d) Energy Facilities (11 AAC 112.230). The Statewide energy facilities standard requires that decisions on the siting and approval of energy-related facilities be based, to the extent practicable, on 16 criteria. Practicable as defined in 11 AAC 112.990(18) means feasible in light of overall project purposes after considering cost, exiting technology, and logistics of compliance with the standard. The standard also recognizes that the facilities and activities authorized by permits after the issuance of leases in the proposed sale area uses of State concern. The following discussion addresses only those criteria 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 and projected community needs (11 AAC 230(a)(1) and (2)). Any pipeline landfalls along the Chukchi Sea coast would require a new facility to be constructed to support the offshore operations and to serve as the first pump station. A likely location for the shore-base facility would be between Icy Cape and Point Belcher (near Wainwright). An overland pipeline would transport oil to TAPS, or a nearer gathering point within the NPR-A or in the Kuparuk River area. Disturbance from these construction activities would be temporary and conducted in a manner that would minimize or eliminate any disturbance or adverse environmental or social effects.

Other ACMP standards require that facilities be consolidated and sited in areas of least biological productivity, diversity, and vulnerability (11 AAC 112.230(a)(3)). The NSBCMP also requires that “transportation facilities and utilities must be consolidated to the maximum extent possible” (NSBCMP 2.4.5.2(f), NSBMC 19.70.050.K.6). Onshore activities hypothesized for OCS oil and gas activities in the Chukchi Sea would be consolidated to the extent feasible, and would likely take advantage of any oil and gas infrastructure developed within the NPR-A to reduce overall development costs. The NSBCMP policy 2.4.5.2(c) (NSBMC 19.70.050.K.3) also would 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 (11 AAC 112.230(a)(12), NSBCMP 2.4.4(i), NSBMC 19.70.050.I.9). This standard does not preclude causeways or offshore 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. 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...” (11 AAC 112.230(a)(11)). Landfall sites will conform to this requirement. For example, oil spills pose the greatest threat of all possible effect agents; however, the analyses in Sections IV.C.1.c through IV.C.1.i indicate that these sites do not accentuate the potential for adverse effects in the event of an oil spill.

The NSBCMP 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 oil-spill 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 standard or with the NSB policies related to the siting and approval of energy related facilities are anticipated.

IV.C.1.o(2)(d) Utility Routes and Facilities (11 AAC 112.240). This Statewide standard requires that utility routes and facilities must be sited inland from shorelines and beaches, unless the route or facility is water dependent or water related. Where routes and facilities are sited along the coast, they must avoid, minimize, or mitigate alterations in surface and ground water drainage patterns; disruption in known or reasonably foreseeable wildlife transit; and blockage of existing or traditional access. Assuming that after an offshore pipeline crossed the beach it would continue inland of the beaches, conformance with this policy is possible.

The NSBCMP 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 (NSBCMP 2.4.5.1(f), NSBMC 19.70.050.J.7). 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 NSBCMP 2.4.5.1(h) (NSBMC 19.70.050.J.9), which discourages duplicative transportation corridors from resource extraction sites, or NSBCMP 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 NSBCMP 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.” NSBCMP 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 NSBCMP 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 ft 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 ft of an existing pipeline that is elevated <5 ft. 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 NSB policies related to Utilities Routes and Facilities.

IV.C.1.o(2)(e) Sand and Gravel Extraction (11 AAC 112.260). 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 standard allows sand and gravel to 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. Substantial alteration of shoreline dynamics is prohibited (NSBCMP 2.4.5.1(i), 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 (NSBCMP 2.4.5.2(a) and (d), NSBMC 19.70.050.K.1 and 4).

It is anticipated that sand and gravel, if needed, would be extracted from upland sites. No conflicts are anticipated with this Statewide standard or the NSB policies related to sand and gravel extraction.

IV.C.1.o(2)(f) Subsistence (11 AC 112.270). The Statewide standard allows the ADNR and coastal districts to designate areas important for subsistence use within the coastal area. Activities within designated subsistence areas must avoid or minimize impacts to subsistence uses of coastal resources.

There are no designated subsistence-use areas on the North Slope or in the Chukchi Sea, although it is anticipated that the NSB will designate subsistence-use areas under its revised district plan as a matter of local concern. Subsistence uses of coastal resources and maintenance of the subsistence way of life are primary concerns of the residents of the NSB. NSB 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 NSBCMP policies relate to adverse effects to subsistence resources. The NSBCMP 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.3.a) relates to “development that likely would result in significantly decreased productivity of subsistence resources or their ecosystems.” Policy 2.4.5.1(b) (NSBMC 19.70.050.J.3.b) relates to “development which restricts subsistence users access to a subsistence resources.”

Disturbance and noise resulting from the hypothesized postlease 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 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 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.

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 NSBCMP policies, however, address “likely” events—a large spill is an unlikely event.

Standard mitigating measures included as part of the proposed sale 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 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.

No conflicts with this Statewide standard or with the NSB policies related to subsistence are anticipated. However, in the 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.

IV.C.1.o(2)(g) Transportation Routes and Facilities (11 AAC 112.280). This Statewide standard requires that transportation routes and facilities must avoid, minimize, or mitigate alterations in surface and ground water drainage patterns; disruption in known or reasonably foreseeable wildlife transit; and blockage of existing or traditional access. The NSBCMP requires “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.” (NSBCMP 2.4.4(a), NSBMC 19.70.050.I.1).

The NSBCMP 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 (NSBCMP 2.4.5.1(f), NSBMC 19.70.050.J.7). 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 standard for energy facilities, transportation facilities are expected to be consolidated to the maximum extent possible. Therefore, there should be no conflict with either NSBCMP 2.4.5.1(h) (NSBMC 19.70.050.J.9), which discourages duplicative transportation corridors from resource extraction sites, or NSBCMP 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.

The final policy falls under the category of “Minimization of Negative Impacts.” NSBCMP 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 NSBCMP 2.4.6(d) (NSBMC 19.70.050.L.3) requires airports and helicopter pads to be sited, designed, constructed, and operated in a manner that minimizes their impact upon wildlife. NSBCMP 2.4.6(e) (NSBMC 19.70.050.L.5) 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. 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 NSB policies related to Transportation Routes and Facilities.

IV.C.1.o(2)(h) Habitats (11 AAC 112.300). The Statewide standard for habitats contains policies specific to nine habitats within the coastal area; these habitats are: offshore areas; estuaries; wetlands, tideflats; rocky islands and seacliffs; barrier islands and lagoons; exposed high-energy coasts; rivers, streams, and lakes; and important habitat. Under the State standard, important habitats must be designated. There currently are no designated important habitats on the North Slope or the adjacent Chukchi Sea. The ADNR, however, may identify and designate important habitats in a departmental planning effort or within the context of a consistency review under 11 AAC 110. The ACMP Statewide standards requires the various habitats in the coastal zone to be managed to avoid, minimize, or mitigate significant adverse impacts to the unique characteristics for which the habitat is identified.

The NSBCMP contains a district policy that reiterates the applicability of the statewide standard (NSBCMP 2.4.5.2(g), 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 NSBCMP district policy requires 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” (NSBCMP 2.4.5.2(b), 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” (NSBCMP 2.4.4(a), 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 (Sec. II.B). The analyses in Sections IV.C.1.f through IV.C.1.h 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 areas; estuaries, tideflats, 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 areas must be managed to avoid, minimize, or mitigate significant adverse impacts to competing uses such as commercial, recreational, or subsistence fishing, to the extent that those uses are determined to be in competition with the proposed use (11 AAC 112.300(b)(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 event that an oil spill occurred in a sensitive area, or in specific coastal areas during critical periods for several fishes. Effects identified in Section IV.C.1.d 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; NSBCMP 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, and it is anticipated that seismic exploration can proceed in conformance with the associated district policy, as discussed in the seismic-survey PEA (USDOI, MMS, 2006a).

Estuaries, tideflats, barrier islands and lagoons characterize the Chukchi Sea coast where some of the development associated with OCS oil and gas leasing is assumed to occur. These habitats are managed to avoid, minimize, or mitigate significant adverse impacts to water flow and natural water circulation, drainage, or sediment patterns. Although disruptive activities could occur in these habitats during pipeline laying and construction of landfall sites, effects of offshore construction on waterflow, circulation, and tidal and wave action would be localized and would last for only a short period of time during construction. Consequently, no conflict with this policy is anticipated.

Much of the uplands in the NSB 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 Corps of Engineers. Therefore, onshore development would need to be designed and constructed to avoid, minimize, or mitigate significant adverse effects water flow and natural drainage patterns (11 AAC 112.300(b)(3)). Pipelines and roadways would transect this habitat. 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 (Sec. IV.C). It is expected that any onshore development will proceed in keeping with this wetland policy; no conflicts are anticipated.

Rivers, lakes, and streams are managed to protect natural water flow, active flood plains, and natural vegetation within riparian management areas (11 AAC 112.300(b)(8)). 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. Gravel extraction also is regulated under policies that are described in the section on sand and gravel extraction. 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 NSB policies related to Habitats.

IV.C.1.o(2)(i) Air, Land, and Water Quality (11 AAC 112.310). The air, land, and water quality standard of the ACMP incorporates by reference all the statutes and regulations of the ADEC with respect to the protection of air, land, and water quality and constitute the exclusive component of the ACMP with respect to those purposes. The NSB reiterates this standard in its district policies and emphasizes the need to comply with specific water and air quality regulations in several additional policies (NSBCMP 2.4.3(h), NSBMC 19.70.050.H).

The agents associated with petroleum development 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. Section IV.C.1.a discusses the effects of an accidental oil spill. Other effects of postlease sale activities would not significantly affect regional water quality. The increased turbidity from permitted construction activities such as dredging would be localized and short term in duration. Trace metals from permitted discharges of drilling muds and cuttings over the life of the field could exceed sublethal levels but over only within a few square kilometers surrounding the discharge point.

As a precaution against accidental spills, the NSBCMP requires the use of impermeable lining and diking for fuel-storage units with a capacity greater than 660 gal (NSBCMP 2.4.4(k), NSBMC 19.70.050.I.11). Development within 1,500 ft 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 also comply with the conditions of the best-effort policies (NSBCMP 2.4.5.1(d), NSBMC 19.70.050.J.3.d). 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. 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 MMS with appropriate oversight and regulatory authority.

Some discharges and emissions would occur during exploration and development, and the NSBCMP 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 localized and temporary (only during active discharges). During development, the effects from disposal of muds and cuttings would also be local and short term. Discharge of produced waters is regulated through a USEPA 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 USEPA has prohibited discharge of formation waters into waters <10 m deep; underground injection projects have been the standard. If produced waters were discharged to surface waters, the discharge would be regulated under a NPDES permit issued by the USEPA. If produced waters were injected into a subsurface formation, as is expected, it would be regulated under an Underground Injection Control permit, issued by USEPA on Federal OCS acreage and the Alaska Oil and Gas Conservation Commission on state submerged and onshore acreage. Recent offshore developments (e.g., Endicott and Northstar) have injected such wastes in dedicated Underground Injection Control wells rather than discharging them to surface waters.

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 NSBCMP 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 NSBCMP also contains a policy that requires development without a central sewage system to impound and process effluent to meet State and Federal standards (NSBCMP 2.4.4(e), 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.

Air quality also must conform to Federal and State standards (11 AAC 112.310, NSBCMP 2.4.3(h) and 2.4.4(c), and NSBMC 19.70.050.H and I.3). The analysis in Section IV.C.1.b indicates that conformance is anticipated, and no conflict between air quality and coastal policies should occur.

No conflicts are anticipated with the Statewide standard or with the NSB policies related to Air, Land, and Water Quality.

IV.C.1.o(2)(j) Historic, Prehistoric, and Archaeological Resources (11 AAC 112.320). The ACMP Statewide standard allows the ADNDR and coastal districts to designate areas of the coastal zone that are important to the study, understanding, or illustration of national, state, or local history or prehistory, including natural processes. A project within such a designated area must comply with the applicable requirements of AS 41.35.010 – 41.35.240 and 11 AAC 16.010 – 11 AAC 16.900.

There currently are no designated historic, prehistoric, and archaeological resources areas on the North Slope or in the adjacent Beaufort Sea. The ADNDR, however, may designate such historic, prehistoric, and archaeological resources areas in a department planning effort or within the context of a consistency review under 11 AAC 110.

The NSBCMP 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 NSBCMP 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 NSBCMP policies establish clearly what is required. In the 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 NSBCMP 2.4.3(f) and 2.4.5.2(h) (NSBMC 19.70.050.F and 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 an archaeological resource may exist 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 statewide and NSBCMP policies relating to Historic, Prehistoric, and Archaeological Resources are anticipated.

Summary. Conflicts with the Statewide standards of the ACMP and the NSBCMP policies are not expected. Through the use of mitigation 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 EPs and DPPs 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. 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.

Conclusion. No conflicts with the Statewide standards of the ACMP or with the enforceable policies of the NSBCMP are anticipated.

IV.C.1.p. Environmental Justice.

IV.C.1.p(1) Overview.

General Discussion: Environmental Justice (EJ) 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 (EO) requires each Federal Agency to make the consideration of EJ 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 USEPA defines EJ 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; USEPA, 2006). Specifically, the EO requires an evaluation as to whether the proposed project would have "disproportionately high adverse human health and environmental effects...on minority populations and low income populations." The EO also includes consideration of potential effects to Native subsistence activities and, to this end, MMS continues to maintain a dialogue on EJ with local communities in this region.

Since 1999, all MMS public meetings have been conducted under the auspices of EJ. Environmental Justice-related concerns are taken back to MMS management and incorporated into environmental study planning and design, environmental impact evaluation, and the development of mitigating measures.

Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments*, requires Federal Agencies to consult with tribal governments on Federal matters that significantly or uniquely affect their communities. In January 2001, a USDOJ Alaska Regional Government-to-Government policy was signed by all the USDOJ Alaska Regional Directors, including MMS. In acknowledgement of the importance of consultation, the MMS invites tribal governments to participate in its environmental assessment processes.

The Inupiat People of the North Slope and the Northwest Arctic boroughs have made MMS aware of the potential burden of participating in too many planning and public meetings. Therefore, MMS has taken measures to more carefully plan the number and timing of meetings with regional tribal groups and local governments. The following three aspects of Inupiaq demographics and culture relate particularly to Environmental Justice: race, income, and consumption of fish and game.

IV.C.1.p(2) Demographics.

IV.C.1.p(2)(a) Race. Alaska Inupiat Natives, a recognized minority, are the predominant residents of the NSB and Northwest Arctic Borough (NWAB), which make up the Alaska regional governments in the Proposed Action area. The 2000 Census counted 7,385 persons resident in the NSB; 5,050 identified themselves as American Indian and Alaskan Native for a 68.38% indigenous population. In the NWAB, the 2000 Census counted 7,288 persons, 5,944 identified themselves as American Indian and Alaskan Native for an 82.5% indigenous population (USDOC, Bureau of the Census, 2000).

Inupiat Natives are the only minority population allowed to conduct subsistence hunts for marine mammals in the region and, in potentially affected Inupiat communities, there are no significant numbers of “other minorities.” Additionally, “other minorities” would not be allowed to participate in subsistence marine mammal hunts and, therefore, would not constitute a potentially affected minority population (NSB, 1999).

Because of the NSB and NWAB’s homogeneous 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 nonminority group does not exist in a geographically dispersed pattern along the potentially affected area of the NSB and the NWAB. Population counts from the 2000 Census for Native subsistence-based communities in the region and their total American Indian and Alaskan Native population percentages can be seen in Table III.C.16.

IV.C.1.p(2)(b) Income. The U.S. average median household income in 2000 was \$42,148, and the U.S. average per-capita income was \$29,469. The Alaskan average median household income in 2000 was \$50,746, and the Alaska average per-capita income was \$29,642. The average NWAB median household income (\$45,976) was below the State average but above the national average, but the average per-capita income (\$15,286) was below State and national averages. The median household incomes of the subsistence-based communities of Kivalina (\$30,833), Buckland (\$38,333), and Deering (\$33,333) were below State and national averages, and those for Kotzebue (\$57,163) and Noorvik (\$51,964) were above. Per capita incomes in all these communities were below State and national averages.

Low income commonly correlates with Native subsistence-based communities in coastal Alaska; however, subsistence-based communities in the region qualify for EJ analysis based on their racial/ethnic minority definitions alone (USDOC, Bureau of the Census, 2000, 2002). The poverty-level threshold for a family of four, based on the U.S. Census Bureau, 2000 Survey data, is \$17,761. Low income is defined by the U.S. Census Bureau as 125% of the poverty level or \$22,201. Median household incomes for the NSB and the NWAB fall well above the Census Bureau threshold for low income. The 2000 Census “tiger” files (files from the U.S. Census’ Topologically Integrated Geographic Encoding and Referencing [TIGER] database) identify no nonsubsistence-based coastal communities in the NSB and the NWAB with median household incomes that fall below the low income threshold.

The median household, median family, and per capita incomes; the number of people in poverty; and the percent of the total Borough or Native subsistence-based community population are shown in Table III.C-17.

IV.C.1.p(2)(c) Consumption of Fish and Game. As defined by the NSBMC, 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” (ADNR, 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 and Northwest Arctic depend. For a more complete discussion

of subsistence and its cultural and nutritional importance, see Section III.C.1.1 (Subsistence Harvest-Patterns).

Potential effects focus on the Inupiat communities of the region. The sociocultural and subsistence activities of these Native communities could be affected by accidental oil spills. Possible oil-spill contamination of subsistence foods is a concern regarding potential effects on Native health. Interestingly, after the EVOS, 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 (USFDA) 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 because of the risk of consumption of contaminants 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 EVOS, 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 EVOS, even when agency testing maintained that consumption posed no risk to human health (State of Alaska, Dept. of Fish and Game, 1995; 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 EVOS, 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 EVOS 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.1.p(2)(d) Health Status. This section will summarize the current health status of the North Slope Inupiat, the changes which have taken place over the past 50 years, and the important determinants of public health in the North Slope communities. Residents have expressed many concerns regarding the possible health effects of oil and gas exploration and development both on- and offshore the North Slope. Increasingly over the last 2 years, the NSB and local and regional Tribal Governments have begun to advocate for a more systematic appraisal of human health concerns in the EIS process. This section represents the results of a recent series of meetings between the NSB and the MMS on this issue.

For our analysis of health effects, we have chosen a definition of “health,” from the World Health Organization. This is perhaps the most widely quoted definition of health in common usage in the field of public health: “A state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity”(World Health Organization [WHO], 1946).

The disease and mortality figures discussed in this EIS are age-adjusted unless otherwise specified.

Alaskan Native health has undergone profound changes over the last 50 years, and the changes in health status among the Inupiat residents of the North Slope mirrors Statewide trends in Alaskan Native health

status in many respects. Since 1950, general health indicators, including infant mortality, overall mortality, and life expectancy have improved significantly, a transition that has been witnessed in American Indian Tribes throughout the U.S. However, over the same time period cancer; chronic diseases (such as diabetes, hypertension, and asthma); and social pathology have increased.

Much of the overall improvement in mortality figures is attributable to decreased rates of infectious diseases such as tuberculosis. In 1950, tuberculosis was the leading cause of death, causing over 45% of deaths; by 2000, the proportion of deaths caused by infection had fallen to 1.3% life expectancy at birth had increased from 46.6 to 69 years, and infant mortality had decreased from 90/100,000 to 9.5/100,000. The most rapid improvement in general health indicators occurred in the 1950's and 1960's. However, since 1979, health status has continued to improve based on general indicators, with a decline of roughly 20% in all-cause mortality (Goldsmith, 2004; Bjerregaard and Young, 2004; Provost et al., 2006).

The earlier improvements were facilitated by a combination of regionwide increases in general socioeconomic status (a powerful determinant of health); improved housing, sanitation, and health care; and specific infection control efforts. Since 1979, much of the continued improvement in mortality figures can be accounted for by decreasing fatality from injuries. Mortality from unintentional injury, the second leading cause of death in Alaska Natives, accounts for much of the more recent improvement, with a decline of roughly 40% between 1979 and 1998. Much of this change can be attributed to local health departments' injury-prevention programs and the efficacy of local alcohol control and local prohibition ordinances (Lanier et al., 2002; Goldsmith et al., 2004).

But despite these improvements in overall mortality figures, significant health disparities remain and cancer, social pathology, and chronic diseases are rapidly increasing. Health disparities between Alaskan Natives and American Indians and the general U.S. population constitute one of the top priorities in current public health efforts. Life expectancy at birth for Alaskan Natives remains significantly lower than for the general population (69 compared with 76 years.) Since 1979, Alaskan Native mortality rates remain roughly 30% higher than the U.S. population and on the North Slope, overall mortality rates are 1.5 times higher than the U.S. population. Rates of assault, domestic violence, and unintentional and intentional injury and death (homicide and suicide) on the North Slope remain far higher than in the general U.S. population, despite the improvements noted above in unintentional injuries (Lanier et al., 2002; Provost et al., 2006; Goldsmith et al., 2004; U.S. Department of Health and Social Services, 2006).

To understand the changes in Inupiat health status and the reasons behind the current health disparities in general health indicators, it is useful to examine the prevalent health issues among the North Slope Inupiat communities individually:

1. Cancer: Cancer has increased roughly 50% since 1969, and is now the leading cause of death on the North Slope. Three cancers—breast, colon, and lung—account for much of the overall increase. North Slope Alaskan Natives have the highest incidence of cancer in Alaska, at 579/100,000. Cancer mortality rates for Alaskan Natives, including North Slope residents, also are significantly higher than the US—303/100,000 on the North Slope, compared with 163/100,000—a disparity of great concern to health care providers in the state (Lanier et al., 2002; Provost et al., 2006; Goldsmith et al., 2004; Lanier and Kelly, 2003).

A substantial percentage of the increase in cancer incidence, particularly for lung cancer, is attributable to smoking. There may be other, less significant environmental factors also at work, such as environmental contamination due to increases in industrialization, the use of locally generated electricity and of vehicles, and the adoption of highly insulated housing. The disparate mortality rates are less well understood. The possible contribution of environmental factors such as contaminants in subsistence resources is of great concern to local residents but does not likely constitute the sole or, perhaps, the most likely explanation. Current public health efforts focus on smoking cessation, early detection, surveillance of carcinogens in subsistence foods, and curtailing exposure to known carcinogenic compounds as much as possible while encouraging the continued use of subsistence foods.

2. Psychological and Social Problems: Social and psychological problems, including alcohol and drug problems, accidental and intentional injury (a high percentage of which are associated with alcohol use), depression, anxiety, and assault and domestic violence, now are highly prevalent on the North Slope (as

they are in many rural Alaskan Native and Inuit villages) and cause a disproportionate burden of suffering and mortality for these communities. Suicide, which was historically rare, has undergone a complete demographic shift. Overall suicide rates have increased dramatically since 1960 (Kraus and Buffler, 1976; Hicks and Bjerregaard, 2006). The prevalence of suicide on the North Slope in recent years has been estimated at roughly 45/100,000, more than four times the rate in the general U.S. population. Still more strikingly, the age distribution of suicide has shifted to become a phenomenon of youth; whereas, before 1960 it had been exceedingly rare, and generally occurred primarily among elderly individuals. The rate of suicide among young Inupiat men in the Alaskan Arctic has been documented as high as 185/100,000, nearly 16 times the national rate (Wexler, 2006). Domestic violence and child abuse also now are generally acknowledged as epidemic problems in rural Alaskan communities and also internationally, in other arctic indigenous communities. Unprocessed arrest data from the U.S. Department of Health and Social Services in 2000-2003, for example, show rates of rape and assault from 8-15 times the national rate (U.S. Department of Health and Human Services [DHHS], 2006). Homicide rates have dropped more than 50% since 1979, but they remain markedly higher than the U.S. population. Alcohol and substance abuse are thought to contribute substantially to rates of these problems (Lanier et al., 2002; Provost et al., 2006; ANTHC, 2006).

Research in circumpolar Inuit societies suggests that social pathology and related health problems, which are common across the Arctic, relate directly to the rapid sociocultural changes that have occurred over the same time period (Bjerregaard and Young, 2004; Curtis and Kvernmo, 2005; Goldsmith, 2004). On the North Slope, suicide rates increased dramatically in the 1960's-1970's and, since 1979, have remained relatively constant but dramatically higher than the overall U.S. rates.

3. Injury Rates: Injury, including unintentional (or accidental) injury, suicide, assault, and homicide, is the second leading cause of death on the North Slope. Accidental injury rates have declined 43% since 1979, but mortality from accidental injury remains 3½ times more common for Alaskan Natives than U.S. whites (Lanier et al., 2002; Provost et al., 2006). Injury is the second leading reason for hospitalization after childbirth. Figures from the Alaska Trauma Registry indicated that the hospitalization rate for injuries on the North Slope was the highest in the State, at 141/10,000 residents, and more than twice the State average. Alcohol has been estimated to be involved in up to 40% of injuries and traumatic deaths of Alaskan Natives (ANTHC, 2006).

Unintentional injury rates are high in the North Slope not only because of the challenges of life in arctic Alaska, but also because of factors such as high rates of alcohol and substance abuse, and risk-taking behavior in youth (ANTHC, 2006). Some authors have suggested that many "accidental" injuries in younger people actually may reflect abnormal risk-taking or latent suicidal behaviors.

4. Diabetes and Metabolic Diseases: Diabetes, obesity, and related metabolic disorders were previously rare or nonexistent in the Inupiat. Diabetes rates in the North Slope are low compared with other Alaskan Native groups, and extremely low compared with all American Indians, but have begun to climb quite rapidly (Murphy et al., 1995; ANMC Diabetes Program). The prevalence of diabetes in the North Slope is estimated at only 2.4% compared with the U.S. rate of roughly 7%. However, between 1990 and 2001, the rate of diabetes climbed roughly 110%, nearly three times the rate of increase in the general U.S. population (ANMC Diabetes Program). Subsistence diets and the associated active lifestyle are known to be the main protective factors against diabetes. The increase in diabetes is felt to reflect increased use of store-bought food and a more sedentary lifestyle, potentially against the backdrop of a baseline genetic susceptibility (Murphy et al., 1995; Naylor et al., 2003; Ebbesson et al., 1999).

5. Cardiovascular Disease: Cardiovascular disease rates, the second leading cause of death in Alaska, are significantly lower in Alaskan Natives than in U.S. non-Natives. On the North Slope, recent mortality figures show death rates roughly 10% less than the U.S. population (Provost et al., 2006). However, as discussed under Diabetes and Metabolic Diseases, many of the risk factors are increasing, and smoking rates are already extremely high (Wells, 2004). As in the case of diabetes, many public health researchers have explained the lower mortality from cardiovascular disease as stemming primarily from subsistence diets and the associated active lifestyle.

6. Chronic Pulmonary Disease: Chronic pulmonary disease mortality rates among Alaskan Natives have climbed 192% since 1979. North Slope residents have the highest mortality in the State from chronic lung

diseases, at nearly three times the mortality rate for the U.S. (130/100,000 compared with 45/100,000) (Provost et al., 2006). As in the case of cancer, the primary reason for the disparate rates of increase and mortality in pulmonary disease is ascribed to the high smoking rates on the North Slope. However, there may be environmental reasons for the rates of increase as well, such as air pollution generated by industrialization and changes in local energy use (see above). Because there are no available data on local fine-particulate concentrations, no data on hazardous air pollutants, and little data on intraregional variation in other USEPA-criteria pollutants, it is impossible to determine the possible contribution of these environmental factors.

In the U.S. in recent years, the field of public health has focused on efforts to explain and address health disparities between ethnic groups and social classes. That health disparities tend to accrue predominantly in minority and low-income populations is an indication of the vulnerability of these groups to outside societal-level influences on health status.

An impressive body of data has demonstrated a direct association between measurable societal factors that have been collectively termed the “social determinants of health” (SDH) – including income inequity within a society, the “social gradient” (or disparities of social class), stress, social exclusion, decreasing social capital (the social support networks which provide for needs within a group or community), unemployment, cultural integrity, and environmental quality, and the incidence, prevalence, and mortality rates of many specific diseases. These disparities persist, and can be dramatic, even after controlling for standard risk factors such as smoking rates, cholesterol and blood pressure levels, and overall poverty. The World Health Organization provides an excellent review of the data regarding the importance of the social determinants of health to overall health status (Wilkinson and Marmot, 2003), and much of the current focus within the U.S. Centers for Disease Control (USCDC) is on addressing health disparities through the determinants of health framework (see USCDC Social Determinants of Health Working Group, at <http://www.cdc.gov/sdoh/>).

The determinants of health status in North Slope Inupiat communities are complex and reflect a wide array of considerations, including genetic susceptibility, behavioral change, environmental factors, diet, and sociocultural inputs. Identifying the potential influences, or “determinants,” of health status is an essential step for public health programs seeking to address health disparities. State, regional, and village-specific influences on health and health behavior can be directly or indirectly associated with past oil and gas development on the North Slope. For example, modernization and socioeconomic change are common to all of rural Alaska, and are one of the dominant influences on the evolution of health status. As noted above, North Slope petroleum development provided the economic and tax base that funded much of the programs and activities that define these changes in rural Alaska. The associations between these influences and oil and gas development can be very complex and indeterminant. For example, regional differences exist between the NSB and other rural regions such as the NWAB in terms of family income and employment status, largely related to oil and gas taxation and employment opportunities that came into being not because of the oil development alone, but because of the establishment and policy making of the NSB. Similarly, the North Slope community residents of Nuiqsut have experienced village-level socioeconomic changes related not only to the State and regional-level influences discussed above, but also from local social and economic influences of the petroleum industry from the Alpine oilfield (e.g., profits of the Kuukpik Corporation, shifts in income distribution, oilfield-related employment, the increased presence of oil workers in the village, a new road connection to the Alaska road system, and changes in hunting patterns and availability of game due to oil-related infrastructure).

Public testimony on prior NEPA-based on- and offshore actions in the region has indicated a persistent concern that regional industrialization may be at the root of some of the human health disparities described above. For example, testifying in 2001 on the MMS’ Liberty draft EIS, Rosemary Ahtuanguaruk, a former health aide who received advanced training as a physician’s assistant, stated:

Increased incidents of community social ills associated with rapid technological and social change cause problems with truancy, vandalism, burglary, child abuse, domestic violence, alcohol and drug abuse, suicide, and primarily the loss of self-esteem. This has materialized during transient employment cycles. The influx of construction workers brings their own problems to a village impacted by oil development activities already. Historically, from past experience, we know that the incidents of alcohol and drug use increase dramatically. (USDOJ, MMS, 2001b)

Similarly, former North Slope Borough Mayor George Ahmaogak noted that:

The benefits of oil development are clear—I don't deny that for a moment. The negative impacts are more subtle. They're also more widespread and more costly than most people realize. We know the human impacts of development are significant and long-term. So far, we've been left to deal with them on our own. They show up in our health statistics, alcohol treatment programs, emergency service needs, police responses—you name it. (Ahmaogak, 2004)

In summary, the health status of the North Slope Inupiat people has improved significantly since the 1950's. However, this era also has witnessed the emergence of significant new pathologies, most importantly cancer and cardiovascular and metabolic problems, as well as a substantial increase in social pathology. The reasons for the improvements, the continuing disparities, and new problems are very complex and originate in many different sources. Few existing data would either support or deny resident concerns regarding degradation of environmental quality and local health impacts; however, while existing data do not allow the direct attribution of a percentage of a health burden to a specific development project, a consideration of regional health data does allow for the recognition of risks. In general, the field of public health responds to concerns of environmental health impacts through efforts to control exposure to environmental contaminants rather than through attempts to identify specific increases in disease rates with specific exposures.

IV.C.1.p(3) Impact Assessment Overview. Coastal communities could experience impacts on subsistence resources and subsistence-hunting practices. These changes could occur as a result of 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; and oil spills. Most Alaskan coastal communities are rural and predominantly Native (a defined ethnic minority), and many contain at least subpopulations with low incomes. Therefore, specific local minority (and possibly poor [low-income]) populations are present that could be potentially affected by proposed activities.

For these reasons, the MMS socioeconomics studies agenda has emphasized the documentation of subsistence uses, and the potential impacts of OCS activities on such uses, along with the more general characterization of rural (Native and non-Native) social organization and the incorporation of local and traditional knowledge. The MMS-sponsored studies have focused most heavily on communities on the North Slope (the area of most onshore and offshore oil and gas activity) and MMS has funded projects to synthesize local and traditional knowledge. The MMS has recognized the extreme importance of whales and whaling to the North Slope communities, and has conducted a bowhead whale aerial survey annually since 1987. The MMS study, *Quantitative Description of Potential Impacts of OCS Activities on Bowhead Whale Hunting and Subsistence Activities in the Beaufort Sea*, is ongoing.

Perhaps more importantly, MMS has recognized the importance of local consultation, and the important role that the NSB, the NWAB and other local organizations and institutions can play in the development and evaluation of specific actions. Such a consultation process will also be a part of all actions addressed in this EIS. Although MMS has amassed an astounding body of public testimony—much of it from Alaskan Natives—as a result of the public hearing process, the Agency's consultation process extends far beyond these formal hearings. The MMS now routinely includes Native representation on the Scientific Review Boards for its major projects, and tries to conduct at least occasional Information Transfer Meetings (discussing the findings of recently concluded and ongoing studies and proposed efforts) near those communities most likely to be affected. The most recent meeting, the Chukchi Sea Science Update Meeting, was held in Anchorage in October 2005.

Major concerns expressed at public meetings included:

- Identifying and protecting important subsistence areas (all 6 communities)
- Restricting access to subsistence areas and resources (5 communities)
- Studying and maintaining the health of wildlife (3 communities)
- Providing natural gas to local communities (3 communities)
- Studying caribou and fish (3 communities)
- Mitigating seismic disturbance of caribou, fish, and whales (3 communities)

- Making better use of traditional knowledge (3 communities);
- Providing more local hire (3 communities)
- Updating outdated resource data (2 communities)
- Involving local people in scientific studies of resources (2 communities)
- Including local people in the planning process (2 communities)

Many of these issues are discussed in government-to-government consultation with tribes and the Inupiat Community of the Arctic Slope and in meetings with the NSB and the AEWC. The MMS conducted outreach meetings under the auspices of EJ from December 2005 through March 2006 with regional and local governments and tribes in Barrow, Wainwright, Point Lay, and Point Hope to consult on current stakeholder concerns and issues with regard to upcoming offshore exploration and leasing in the region, and specifically concerning seismic activities planned for the 2006 open-water season. One overarching way MMS has tried to address Native concerns has been to include local Inupiat traditional knowledge in its environmental assessments and environmental impact statements.

IV.C.1.p(4) Potential Effects on Health Status. For many years, residents of the NSB have expressed human health concerns related to oil and gas development in the region. Reflecting a growing concern regarding the potential community health effects of currently proposed and foreseeable development, the NSB and local and regional Tribal governments have begun to raise detailed human health issues in their comments. This section reflects the MMS' current efforts to synthesize and analyze these concerns.

As described in Section IV.C.1.p(2)(d), Health Status, human health and illness result from a complex interplay between genetic, behavioral, environmental, and sociocultural "determinants." The potential health outcomes discussed below have been identified through a combination of resident testimony, review of pertinent literature and public health data, and discussion with local, regional, state, and national public health experts.

1. Metabolic Disorders (diabetes, obesity, hypertension, and hyperlipidemia): Diabetes, obesity, hypertension, and hyperlipidemia (collectively termed metabolic disorders here) are among the main risk factors for cardiovascular and cerebrovascular disease, renal failure, and peripheral vascular disease. Metabolic disorders are disproportionately common in American Indian and Alaska Native (AI/AN) populations compared with the general U.S. population, but they occur at lower rates in the North Slope Inupiat than in most other AI/AN groups (Naylor et al., 2003; Zinman, 2006).

The preponderance of Alaskan public health data indicate that subsistence, including both the diet and the active lifestyle involved in hunting, is the most important protective factor against metabolic disorders, and that the risk of developing metabolic health problems increases as the proportion of total dietary intake from subsistence foods decreases. The AI/AN populations are theorized to have a particular genetic susceptibility to diabetes, such that it occurs at a much higher frequency than in the non-Native U.S. population when AI/AN people change to a more "typical" U.S. diet (Murphy et al., 1997; Young et al., 1992; Bjerregaard and Young, 2004; Bjerregaard and Jorgensen, 2004).

Metabolic health effects may accrue if subsistence resources became unavailable or undesirable for use, if subsistence foods were displaced from the diet by increased availability or affordability of store-bought foods, or if subsistence were displaced as a primary source of nutrition because of cultural change. Displacement or contamination of resources that substantially reduce intake of subsistence foods would increase the risk of increased prevalence of metabolic disorders. Public health professionals in Alaska actively promote the health benefits of a subsistence-based diet (Alaska Department of Public Health, 2004a,b).

Data from the Inupiat in Alaska, and from Inuit populations in Greenland and Canada, suggest several points regarding development and industrialization effects on subsistence intake:

- To the extent that local increases in personal income occur, they can facilitate subsistence activities through providing capital to purchase equipment that allows more effective and efficient hunting.
- Modernization, industrialization, globalization, and younger age are known to be factors associated with the displacement of the dietary role of subsistence (Shepard et al., 1996; Bjerregaard and Young,

2004; Balcomb, 2006; Ebbesson et al., 1999). Hence, although subsistence has continued to hold its importance as a cultural value, there is a tendency toward a lower percentage of caloric intake from subsistence foods as modernization and industrialization overtake these communities.

2. Social Pathology (assault, alcohol and drug abuse, domestic violence, suicide, and homicide):

Health outcomes associated with social pathology include hospitalization and mortality from unintentional injury (secondary to alcohol and drug abuse and risk-taking or suicidal behavior); intentional injury (assault, homicide, and suicide); and alcohol and drug abuse. As discussed above, these problems are major sources of morbidity and mortality in North Slope communities. A large body of literature has documented the general association between industrialization and modernization in circumpolar Inuit communities, and social pathology (Curtis and Kvernmo, 2005; Bjerregaard, 2001; Shepard and Rode, 1996; Travis, 1984). Some Alaskan data suggest that well-developed and adequately funded political and social systems can allow communities to channel effects and economic gains toward more beneficial outcomes (Haley, 2004).

Employment: Employment generally is associated with lower rates of social pathologies, but the data pertaining to this question in the Inupiat are complex. For example, one study correlated high suicide rates in the NWAB with rapid sociocultural change in the presence of decreasing employment opportunity (Travis, 1984). Another indicated that full-time employment actually leads to increased stress and decreased overall satisfaction measures because of decreased available time for subsistence activities (Martin, 2005). However, most North Slope residents tend to view employment opportunities as a positive. Predicted increases in overall NSB employment related to the Proposed Action are small.

Economic Development: Economic development generally is viewed as a positive in terms of its effects on sociocultural problems and social pathology. To the extent that the Proposed Action results in increased regional income or local village income, this may result in positive effects. However, if local economic changes result in actual or perceived inequities in a community, significant tensions and stresses may develop. This problem has been noted by researchers in the Nuiqsut area (Galginaitis, 2006, pers. commun.).

Stresses Associated with Sociocultural Change: “Acculturation stress,” or sociocultural tensions and changes to sociocultural values induced by the influence of the “dominant” Western culture, has occurred since Yankee whaling began in 1848. In more recent times, effects on Inupiat villages have been the subject of innumerable residents’ testimony on exploration and development activities onshore as well as offshore. There may be both direct, highly localized effects in addition to effects that are more generalized over the entire region or State. For example, localized tensions may result when a project causes a large influx of transient workers into a single village, generating interracial conflict; feelings of disempowerment among residents wishing to protect their traditional way of life; ambivalence among youth who must rectify their attachment with Inupiat traditional culture and outside, non-Native value systems, modes of communication, diet, and lifestyle; and domestic tensions as family providers feel pressure to be both successful hunters and economic providers. On the other hand, more generalized regionwide acculturative forces include increases in the economic standard of living, employment, and educational opportunity, and economic disparity.

Summary of Effects on Social Pathology: In summary, the Proposed Action could contribute to various ambient and ongoing localized and regional effects on social pathology. The associated health outcomes would be expected to parallel sociocultural changes to some extent. The most important sources of impacts would appear to include:

- Influx of temporary personnel into Inupiat villages, leading to cultural conflicts and the potential for alcohol and drug importation.
- Potential construction of new access routes to remote villages, particularly Wainwright.
- Stress, tension, and increased demands on individual time because of opposition to increasing potential on- and offshore exploration and development.
- Acculturation stress, secondary to influences to disturbances such as the influx of outside oil and gas workers entering a community, marked and rapid socioeconomic changes, and altered availability of subsistence resources.

- Potential local and regionwide increases in income and employment, leading to a general stabilization of social pathology. An important caveat is that increased income disparity, to the extent that it occurs, may tend to increase community tension and may thus worsen these problems.

3. Injury Rates: Injury rates also are discussed in the immediately preceding discussion of “social pathology.” As summarized in Section III.B.15.d, injury is the second leading cause of death in the North Slope, and the leading reason for non-obstetric hospitalization. Injury rates could be affected through three pathways:

- (i) Displacement of subsistence animals resulting in increasing the time and effort needed to harvest resources..
- (ii) More erratic and aggressive behavior of subsistence animals disturbed by oil and gas activities, as some residents have observed regarding the behavior and migration patterns of caribou onshore and bowhead whales in proximity to seismic activity nearshore and offshore.
- (iii) Social pathology leading to increased rates of alcohol and substance abuse and, hence, increasing the risk of accidents, as discussed above.

The degree to which injury rates change as a result of the Proposed Action will depend on the degree to which the potential impacts on sociocultural characteristics, subsistence, and drug and alcohol importation into the villages occur.

4. Health Problems Related to Airborne Emissions: According to the air quality analysis in Section IV.B.3.a. the overall air quality impacts of the proposed action are projected to be low. This section will address the potential impacts of projected emissions on human health.

Airborne emissions from on- and offshore activities, as classified by the USEPA, include the USEPA “criteria pollutants” (NO_x, SO_x, PM₁₀, PM_{2.5}, ozone, lead, and CO), as well as volatile organic compounds (VOC’s), and hazardous air pollutants (HAP’s). The criteria pollutants have been associated with an array of health effects, the most common and significant of which include causing and exacerbating respiratory illnesses such as asthma, increased risk of cardiac arrhythmias, exacerbated atherosclerotic coronary artery disease, and excess mortality among vulnerable groups. According to the USEPA, PM_{2.5} in particular is associated with “increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing, for example; decreased lung function; aggravated asthma; development of chronic bronchitis; irregular heartbeat; nonfatal heart attacks; and premature death in people with heart or lung disease” (USEPA, 2005). “Hazardous air pollutants” and “volatile organic compounds” are a diverse group of contaminants with an array of health effects including an etiologic role in certain cancers, cognitive and neurodevelopmental delays, endocrine disorders, and immunological problems. The HAP’s and VOC’s can contact human populations either directly through emissions, or through concentrating in the food chain.

Based on the MMS’ conclusion that overall contributions to decreased air quality under the Proposed Action will be low, the impact to human health from the Proposed Action also is likely to be low. Regional variations, however, certainly could occur, with potential implications for human health.

5. Infectious Disease: Increased travel, the introduction of new populations, and the influx of visitors and temporary workers from outside the North Slope region represents a potential source of infectious disease transmission, including sexually transmitted diseases, respiratory diseases, and other infections, to local residents. Given the baseline prevalence of chronic respiratory illness (see Sec. IV.C.1p(2)(d)) in this community, transmission of respiratory infections such as influenza could pose a risk to Inupiat villages, particularly to elders and people with chronic pulmonary disease.

The rates of HIV and syphilis are substantially lower in the North Slope than in the Alaskan and U.S. general population (State of Alaska, Epidemiology Section, 2004, 2005). Chlamydia rates are much higher in Alaskan Natives than non-Natives in Alaska, but there are no North Slope-specific data available at this time (State of Alaska, Epidemiology Section, 2006).

6. Environmental Contaminants: For many years, North Slope residents have expressed concerns regarding possible contamination of the environment, and in particular of subsistence foods, by local industrial development, and the potential effects to human health. Environmental contaminants may enter the human environment through airborne emissions (as discussed above); through liquid and solid-phase discharges such as drilling muds, and spills; and biomagnification through the food chain.

The NSB has maintained an extensive program of monitoring and testing subsistence resources for contaminants. The results have been encouraging, in that to date, the levels of contaminants such as PCB's in subsistence foods have been substantially lower than those reported in similar resources in Canada and Greenland. One important study also documented the presence of PCB's in store-bought foods and made the point that there is no available food source that prevents exposure to such contaminants altogether (O'Hara, 2005). The Alaska Department of Health has also summarized data on PCB's and mercury in subsistence foods, and concluded with a strong recommendation that people continue eating subsistence foods because, given the relatively low levels of contaminants present, the health benefits clearly outweigh the risks (Alaska Department of Health 2004a,b). A 1999 report by the Alaska Native Health Board, *Alaska Pollution Issues*, assessed the risks from radionuclides, persistent organic pollutants, heavy metals, polychlorinated biphenyls, dioxins, and furans, and 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).

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 Alaskan Natives, and USFDA and USEPA action levels 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 USFDA action level, but most have levels below the action level. With the wide margin built in for establishing the USFDA 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).

Kivalina has expressed concerns about elevated levels of lead in the environment originating from the Red Dog Mine and potential human health effects. Concerns about mining effects on the community were raised often by the community and by other concerned groups. These concerns include fears of increases in fugitive dust and accumulations of lead in the sediments below the existing dock facility for the mine. During scoping meetings for the DeLong Mountain Terminal Expansion for the Red Dog Mine, concerns about measurement techniques, what these measurements meant, and their potential effects on human health were mentioned repeatedly. The issue continues to be controversial, because many people feel that any elevation of lead levels in the environment from mine operations or shipping is unacceptable and a threat to human health (U.S. Army Corps of Engineers, 2005).

7. Social Determinants of Health: The "social determinants of health" (SDH) is a term used to describe the powerful and highly reproducible association between an array of socioeconomic and environmental factors (many of which have been studied individually with regard to health outcomes)—including social hierarchy, social exclusion, social support networks, income inequity, employment, educational opportunity, cultural integrity, food security, early childhood environment, and stress—and specific health diagnoses. Summarizing the importance of the SDH to health, a conference in 2002 concluded:

The socioeconomic circumstances of individuals and groups are equally or more important to health status than medical care and personal health behaviours, such as smoking and eating patterns.... The weight of the evidence suggests that the SDOH have a direct impact on the health of individuals and populations, are the best predictors of individual and population health, structure lifestyle choices, and interact with each other to produce health. (Health Canada, 2002).

The WHO, USCDC, and many university-based public health programs have made investigation and mitigation of SDH-related health disparities a major focus of current efforts to improve health, particularly among economically disadvantaged minority populations.

Both on- and offshore oil and gas development has become a dominant socioeconomic force on the North Slope. Its direct and indirect influences through, for example, acculturative pressures, the influx of people from a different culture entering previously isolated Inupiat villages (e.g., teachers, CIP employees, oil workers); stress over perceived and actual threats to culture and subsistence; direct and indirect employment opportunity; and broad economic and infrastructure improvements. It is important to recognize that the potential from changes brought by oil and gas development may create statewide, regional, and local (village-level) effects, as described above. Furthermore, it must be understood that effects on the SDH may create concomitant positive and negative effects on health status. Local and regional SDH effects may be the most important to recognize because their recognition could lead to more effective strategies for mitigation (see, for example, Assai et al., 2006). For example, a local increase in employment may create both benefits through economic opportunity and adverse effects because of tensions between the imperative to provide for one's family through subsistence activities and the pressure to be a successful wage earner. Mitigation could be targeted at efforts to devise flexible work schedules which allow participation in both activities.

Many of the effects discussed contain an EJ component, particularly those discussed in the Health Status discussion above. They will not all be summarized and discussed in detail here. Rather, the central issue of effects on subsistence will be used as a proxy or construct for this potential complex of effects, and will serve as the basis for a discussion of possible mitigation measures. The NSB 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" (ADNR, 1997). While this is, at best, a partial view of the significance of these activities to the Inupiat (and more generally to Alaskan Natives) as individuals, culturally it stresses subsistence as a primary cultural and nutritional set of activities upon which Alaskan Natives depend.

Inevitably, "perceptions of risk" exist among local residents concerned about accidents or new development projects in general, and manifest in fears and concerns for stakeholder cultural rights and resources. Considering the importance of social networks that are maintained through subsistence cultural patterns, any type of disruption adds to cumulative change. The mere fact that, for example, certain members of the NSB engage in actively opposing offshore development cumulates social change.

This section began with a general discussion of EJ and a list of project-specific actions MMS initiated to help mitigate disproportionately adverse effects on Alaskan Natives. More generally, mitigation of potential effects on subsistence activities will involve the protection of biological resources, the orientation of oil and gas personnel to the environmental and cultural concerns of local residents, and extensive consultation with local residents to avoid disruption of their activities. USDO, MMS (2001b and 2003a) both discuss these measures in some detail for the NSB.

IV.C.1.p(5) Standard, Potential, and Ongoing Studies and Mitigation Initiatives. Avoidance planning, stipulations and required mitigation, and conflict avoidance measures (under IHA requirements as defined by NMFS and FWS) would serve collectively to mitigate disturbance effects on EJ (see Sec. III.C.1.1, Subsistence Harvest-Patterns, for a complete discussion of this mitigation).

The Alaska OCS Region promotes studies that directly address the standing issues and concerns of Native stakeholders. The MMS involves local and tribal governments in its studies planning process and has held meetings in all local communities to assist their involvement in this effort. The MMS' participation in the newly formed North Slope Science Initiative ensures MMS' continued involvement in Slope-wide scientific research formulation and coordination.

Particular studies that the MMS has funded to address sociocultural and environmental justice impacts include: the MMS' Bowhead Whale Feeding Study, conducted out of the village of Kaktovik, that includes local Inupiat in the study design, data gathering, and data analysis; the *Arctic Nearshore Impact Monitoring In Development Areas (ANIMIDA)* study (designed specifically to meet requests from the Inupiat community) and its followup study, *Continuation of Arctic Nearshore Impact Monitoring in Development Areas (CANIMIDA)*; 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.

One study that particularly tried to address seismic effects was the *GIS Geospatial Database of Oil-Industry and Other Human Activity (1979-1999) in the Alaskan Beaufort Sea*, completed in 2002. This study was initiated to compile detailed information describing the locations, timing, and nature of oil and gas related and other human activities in the Alaskan Beaufort Sea. An important objective of the database was to assess concerns expressed by subsistence hunters and others living within the coastal villages of the Beaufort Sea about the possible effects that oil and gas activities (particularly seismic activity, drilling, and oil and gas support-vessel activities) had on the behavior of marine mammals, especially the bowhead whale. The Human Activities Database, however, is proprietary because it includes sensitive oil and gas industry data. With the exception of ice-management activity, the compiled information for the period 1990-1998 is relatively complete and considered adequate for the investigation of potential effects of disturbance on the fall bowhead whale migration. However, there are significant gaps in the data for the period 1979-1989. This initiative continues under the ongoing study *Analysis of Covariance of Human Activities and Sea ice in Relation to Fall Migrations of Bowhead Whales*.

Newly funded MMS studies that address sociocultural and environmental justice impacts include:

- (1) *Dynamics of Distribution and Consumption of Subsistence Resources in Coastal Alaska*;
- (2) *Researching Technical Dialogue with Alaskan Coastal Communities: Analysis of the Social, Cultural, Linguistic, and Institutional Parameters of Public/Agency Communication Patterns*;
- (3) *Analysis of Variation in Abundance of Arctic Cisco in the Colville River* (this study has a Traditional Knowledge component);
- (4) *Monitoring the Distribution of Arctic Whales*;
- (5) *Bowhead Whale Feeding in the Central and Western Alaska Beaufort Sea*;
- (6) *Aerial Photography of Bowhead Whales to Estimate the Size of the Western Arctic Population*;
- (7) *Satellite Tracking of Eastern Chukchi Sea Beluga Whales in the Beaufort Sea and Arctic Ocean*;
- and
- (8) *Development of Remote Sensing Survey techniques for Arctic Marine Mammals: Pacific Walrus*.

Other initiatives include an MMS-sponsored Information Transfer Meeting (ITM) 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. In early 2005, MMS held an ITM in Anchorage and a mini-ITM in Barrow. In October 2005, MMS held a Chukchi Sea Science Update Meeting in Anchorage to update its analysts for their work on Sale 193 on the current information base and conditions for oceanography and marine mammal, fish, bird, subsistence, and sociocultural resources. The meeting's other purpose was to develop a studies regime for these resources in the region.

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, as well as links to Alaskan Native sites and U.S. Government Native-related sites. The MMS Alaska OCS Region's community liaison, Albert Barros, was instrumental in getting an Alaskawide Department of the Interior Memorandum of Understanding (MOU) with Alaskan tribes on government-to-government consultation signed by all the Alaska Department of the Interior Agency Regional Directors. The MMS signed an MOU with the community of Kaktovik in March 2005 that specifies consultation procedures with the community. George Ahmaogak, former Mayor of the NSB, is a member of MMS' OCS Policy Committee.

Over the 2 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. Without congressional authorization, 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 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 2001, Congress appropriated impact-assistance funds for coastal states affected by OCS oil and gas production. Nationwide, Congress appropriated \$150 million to be allocated among eligible oil- and gas-producing states. Alaska received an appropriation of \$12.2 million, \$1,939,680 of which went to the NSB, and \$102,530 went to the NWAB. The Coastal Impact Assistance Program (CIAP) was reauthorized by Congress under the Energy Act of 2005. Under the new CIAP, \$250 million for each of fiscal years 2007 through 2010 will be disbursed directly to eligible producing states and to qualifying counties, parishes and boroughs within those states. Under the new CIAP, states eligible to receive funding are Alabama, Alaska, California, Louisiana, Mississippi, and Texas. The CIAP funds will be allocated to these states based on the proportion of qualified OCS revenues offshore of the individual state to total qualified OCS revenues from all states. Because Alaska currently lacks significant OCS production, its contribution to total OCS revenues is much less than the other states. Accordingly, Alaska likely will receive the minimum allocation provided under the program, or \$2.5 million for each year. Thirty-five percent must go to local communities. This amount could rise in the future if Alaska's OCS revenues increase as a result of lease sales, lease rentals, and production.

Twenty-seven percent of all OCS leasing, rental, and royalty receipts, within the first 3 mi of the Alaska OCS, go to the State of Alaska. Also, subsistence-impact funds administered by the USCG under the Oil Pollution Act of 1990 would be available, in the event of an oil spill, to provide for subsistence-food losses.

Since July 2003, MMS and the NSB have been in constant consultation and coordination on a number of issues that include conflict avoidance, oil-spill-risk analysis, peer review of scientific studies, and disturbance effects on subsistence resources, cumulative effects recommendations of the 2003 NRC (2003) Report *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope*, bowhead whale feeding in the Beaufort Sea, deferral area boundaries, and ways to improve stakeholder communication. This ongoing dialogue may result in the development of new mitigation, scientific studies, and avenues of cooperation (USDOJ, MMS, 2004).

Conclusion. Alaskan Inupiat Natives, a recognized minority, are the predominant residents of the communities of Barrow, Atkasuk, Wainwright, Point Lay, Point Hope, and Kivalina, the areas potentially most affected by activities assessed in this EIS. Inupiat Natives could be disproportionately affected by disturbance impacts from seismic activity, vessel, aircraft, and construction noise, oil spills, and potential human health impacts because of their reliance on subsistence foods. "Significant" effects on EJ are defined as: disproportionately high adverse impacts to low-income and minority populations. Potential significant impacts to subsistence resources and harvests and consequent impacts to sociocultural systems could result in adverse EJ impacts.

Avoidance planning, stipulations and required mitigation, and conflict avoidance measures under IHA requirements as defined by NMFS and FWS would serve collectively to mitigate seismic and noise disturbance effects on EJ. Mitigation measures likely would incorporate traditional knowledge and the cooperative efforts between MMS, the State, the people of the North Slope, and tribal and local governments. With required mitigation and conflict avoidance measures in place, significant impacts to subsistence resources and hunts from seismic activity and noise and disturbance would not be expected to occur as a result of this action, thereby avoiding significant impacts on sociocultural systems and disproportionately high adverse impacts on low income and minority populations in the region—significant EJ impacts.

The Sale 193 OSRA assessed the effects of an accidental spill of 1,500 bbl or 4,600 bbl spill on subsistence, concluding that 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. Potential tainting and contamination effects on bowhead and beluga whales and other marine mammals, including polar bears, would be considered significant; effects on seal populations would be lower.

Sale-specific EJ 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 EJ related effects to coastal subsistence oriented communities on the Alaskan and Russian Chukchi Sea coastline from the Proposed Action would occur in event of a large oil spill, which could affect subsistence resources. A large oil spill could contaminate essential whaling areas and marine mammal harvest areas,

and major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Such effects would represent disproportionate high adverse effects to Alaskan Natives in Chukchi Sea communities—significant EJ impacts. Effects are expected to be mitigated substantially, though not eliminated. Furthermore, potential long-term impacts on human health from contaminants in subsistence foods, ongoing and increasing social pathologies due to increasing development activities both on- and offshore, and climate change effects on subsistence resources and practices would be expected to exacerbate overall potential effects on low-income, minority populations.

IV.C.2. Alternative III (Corridor I Deferral).

IV.C.2.a. Water Quality.

If the assessment scenario remains the same for Alternative I, III, or IV, the actions and sources of water quality degradation do not change but are only sited elsewhere. The deferral areas may avoid localized discharges to marine water; however, the removal of the deferred lease blocks would not significantly affect the marine water quality either negatively or beneficially. Compliant postlease activities do not pose a significant degree of risk to water quality (Sec. IV.C.1.a). 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 may occur elsewhere in the sale area.

IV.C.2.b. Air Quality.

Potential air quality impacts would be lower for this Alternative to the adjacent onshore areas than Alternative I (Proposed Action) because of the greater distance from shore of the nearest tract available for leasing. The difference, however, would be negligible.

IV.C.2.c. Lower Trophic-level Organisms.

The effects on lower trophic-level organisms would be due partly to possible discharges and to oil spills that could contact the coastline next to the spring lead system (Sec. IV.C.1.c). Therefore, the deferral of 1,765 whole or partial blocks near the coast would decrease the level of effects, but the relative severity of the individual effects of Alternative III would be the similar to those summarized for Alternative I in Section IV.C.1.c. Specifically, the disturbance effect of 14 anticipated exploratory wells probably would be low, unless the wells were located near any special biological communities; regardless, the MMS would review further any installation proposals and could require surveys. Exploratory discharges during summer probably would lead to low effects without nearshore tracts. Water circulation under the winter ice cover is slow, so we assume that produced water would be reinjected; regardless, the local effects of produced-water discharge for the life of the field probably would be moderate, but any such discharge proposals would be reviewed in detail by MMS and USEPA. We assume that an extensive system of buried pipelines would radiate from a central production platform and that a single pipeline would extend to shore. This pipeline installation would probably disturb 1,000-2,000 acres of typical benthic organisms that would slowly recolonize the area within a decade, leading overall to a major level of effect. The disturbance effects would be assessed and possibly monitored by the MMS and U.S. Army Corps of Engineers. The effects of an alternative to production pipelines—the transportation of produced oil in vessels—would pose a much greater spill risk to the coast adjacent to the spring lead system. The OSRA model estimates a 28% chance of one or more large spills $\geq 1,000$ bbl occurring during the production life of the fields, but a $<0.5\%$ chance of one or more large oil spills occurring and contacting the U.S. Chukchi coastline within three days over the life of Alternative III. If a large oil spill did contact this coastline, the oil probably would persist in a few of the tidal and subtidal sediments for a couple of decades, leading to a local but moderate effect on the few intertidal lower-trophic level organisms. The chance of one or more large spills occurring and contacting the U.S. Chukchi coastline increases to 3% within 30 days over the life of Alternative III, demonstrating the advantages of requirements for rapid response capability. During the abandonment phase, we assume that the extensive pipeline system would be cleaned, plugged, and abandoned in place. Overall, the level of effect of Alternative III on lower trophic-level organisms with standard mitigation would be minor.

IV.C.2.d. Fish Resources.

This alternative would provide the largest deferral area and provide the greatest net resource benefits to fish resources. This deferral area would be in the form of a corridor on the shoreward margin of the proposed sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects further away from important fish habitats. The increased distance between offshore development and coastal fish habitats would conceivably decrease the percent chance of spilled oil contact with nearshore fish habitats, increase weathering of spilled oil prior to contact, and increase available spill-response time.

IV.C.2.e. Essential Fish Habitat.

Alternative III (Corridor I) includes an approximately 104 km (62 mi) setback deferral area along the Chukchi Sea shoreline. This alternative would employ standard mitigation measures described in Section II.B.3.c to avoid or limit the potential impacts to EFH.

In theory, an alternative with a deferral would provide more protection for coastal and marine fish habitat by moving drilling and construction noise disturbances and water quality impacts (exploration and production platform discharges, turbidity) further away from the Chukchi Sea coastline. Many of the potential effect categories remain the same as the Proposed Action, but those anticipated impacts would be lower due to the setback from the coast.

Other potential resource benefits could occur if a large oil spill occurred, because the increased distance to the shoreline conceivably reduces the percent chance that oil would make contact with sensitive coastal resources and the increased time required for oil to travel this greater distance would conceivably allow for a more effective response from spill-response depots. One negative aspect of deferrals is the potential for increased pipeline distances. Increased pipeline distances would increase the potential for a pipeline spill and would result in larger pipeline construction impacts. Overall, the greatest net ecological benefits to EFH would accrue from this alternative because it contains the largest deferral area.

IV.C.2.f. Threatened and Endangered Species.

IV.C.2.f(1) Threatened and Endangered Marine Mammals. This alternative would preclude the development, production, and abandonment of oil and gas activities in the lease blocks within Corridor I, thereby reducing potential conflicts between migrating bowhead whale populations, bowhead whale subsistence hunters, and offshore oil and gas operations. However, seismic surveys (if permitted by the MMS, per 30 CFR Part 251 – Geological and Geophysical Explorations of the Outer Continental Shelf) for the exploration of oil and gas resources in the Chukchi Sea Proposed Action area would be allowed to continue.

Differences in noise and oil-spill effects to bowhead whales from this deferral compared to Alternative I (Proposed Action) and Alternative IV (Corridor II) are difficult to quantify, but qualitatively can be described. While the selection of this alternative decreases the opportunity of discovering a commercial field and the number of oil-spill launch sites, the resources in and adjacent to this area still could be adversely affected by a large oil spill originating from a production site and/or pipeline located elsewhere in the sale area. Therefore, the impacts of oil spills and industrial noise on threatened and endangered marine mammals, as described and analyzed in Sections IV.C.1.f, apply.

The deletion of this area from the lease sale would move sources of industrial noise and sources of crude oil farther offshore and away from the spring lead system, thus somewhat reducing the likelihood of spring bowhead whale encounters with industrial noise. It would not, however, substantially reduce the chance of crude oil contacting the spring-migratory route because: (1) pipelines constructed through the spring-migratory route to transport oil to shore-based processing facilities could leak or rupture; and (2) oil-spill-trajectory models for large spills indicate that depending on the oceanographic and weather conditions, large oil spills outside Corridor I could be transported into the spring-migratory route. However, because this alternative reduces the number of potential oil-spill launch sites and their locations are farther away from the spring-migratory route, any spill that would occur would take longer to reach and enter the spring-migratory route, thus allowing more time to respond to the spill. Because fall migrating bowhead whales

are not expected to use the deferred area, fall bowhead encounters with oil and gas-related industrial noise and oil spills would be the same as for Alternative I (Proposed Action).

IV.C.2.f(2) Threatened and Endangered Marine and Coastal Birds. This alternative would provide the largest deferral area and provide the greatest net resource benefits to spectacled and Steller's eiders (threatened species) and Kittlitz's murrelet (a candidate species). This deferral area would be in the form of a corridor on the shoreward margin of the proposed sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects farther away from important bird habitats, particularly staging and molting areas. Habitat alterations and surface developments would occur outside designated critical habitat for the spectacled eider. The increased distance between offshore development and coastal bird habitats would conceivably decrease the percent chance of spilled oil contact, increase weathering of spilled oil prior to contact, and increase available spill response time.

IV.C.2.g. Marine and Coastal Birds.

This alternative would provide the largest deferral area and provide the greatest net resource benefits to marine and coastal birds. This deferral area would be in the form of a corridor on the shoreward margin of the proposed lease-sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects further away from important bird habitats. The increased distance between offshore development and coastal bird habitats conceivably would decrease the percent chance of spilled oil contact, increase weathering of spilled oil prior to contact, and increase available spill-response time.

IV.C.2.h. Other Marine Mammals.

This alternative would provide the largest deferral area and provide the greatest net resource benefits to marine mammals. This deferral area would be in the form of a corridor on the shoreward margin of the proposed sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects farther away from important coastal habitats. However, because of the lack of data on marine mammal distributions and habitat use in offshore areas of the Chukchi Sea, it is uncertain what the level of effects would be in offshore areas. The increased distance between offshore development and coastal habitats conceivably would decrease the percent chance of spilled oil contact, increase weathering of spilled oil prior to contact, and increase available spill-response time.

IV.C.2.i. Terrestrial Mammals.

This alternative would provide the largest deferral area and would be in the form of a corridor on the shoreward margin of the proposed sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects farther away from important coastal habitats. The increased distance between offshore development and coastal habitats would conceivably decrease the percent chance of spilled oil contact, increase weathering of spilled oil prior to contact, and increase available spill-response time.

IV.C.2.j. Vegetation and Wetlands.

This alternative would have similar impacts on vegetation and wetlands as would Alternative I (Proposed Action), because there is no difference in the activities projected onshore. See Section IV.C.1.j(1) for more details on the impact analysis.

Mitigation on vegetation impacts would include gravel extraction conducted in winter and access to the site by ice roads to ensure minimal impact during gravel extraction and transport. Gravel pits probably would fill with water and be shaped to provide fish and waterfowl habitat.

IV.C.2.k. Economy.

The economic effects of Alternative III (Corridor I Deferral) would be the same as Alternative I (Proposed Action). For purposes of economic analysis, we assume that the full exploration and development scenario for each of the deferral alternatives would occur as for Alternative I. That is, the OCS activity would take place in a different area and be the same for each deferral alternative as for Alternative I.

IV.C.2.l. Subsistence-Harvest Patterns.

This Alternative would exclude 1,765 whole or partial blocks along the shoreward edge of the sale area, potentially reducing impacts to nearshore subsistence resources, habitats, and hunting areas. This alternative was developed by MMS in response to comments received during the scoping process to reduce impacts to bowhead whale subsistence hunting. This alternative would offer for leasing all of the area described in Alternative I except for a corridor extending 60 mi offshore from the Chukchi Sea coastline in order to protect important bowhead whale habitat used for migration, feeding, nursing calves, and breeding and important beluga whale habitat near Point Lay. The Alternative is analyzed for its particular protection of subsistence-whaling areas important to the communities of Barrow, Wainwright, Point Lay, and Point Hope and the subsistence whale hunt.

This deferral would move the shoreward boundary of the lease sale 60 mi offshore, prohibiting leasing, exploration, development, and production activities; thus, moving the zone for potential noise, disturbance, and oil-spill effects farther away from the Chukchi Sea spring lead system, nearshore coastal waters, and onshore habitats. In this way, subsistence resources, habitats, and hunting areas would be afforded more protection from potential impacts. The chance of spring bowhead whale encounters with industrial noise would likely be reduced.

For the Proposed Action, the percent chance of one or more large spills occurring over the production life of the project is 40%; with this alternative, the percent chance of one or more large spills is reduced to 28%. Because potential launch points for oil spills would move seaward, thus, increasing the time for spilled oil to weather, the time to mount oil-spill response could potentially reduce contact and impact. Resources in this area still could be affected by a large oil spill that occurred elsewhere in the sale area, and pipeline routes from farther offshore areas would still cross deferred areas. There would be no reduction in effects from potentially permitted seismic surveys in the sale area as seismic survey permitting is non-lease specific.

Effects on subsistence-harvest patterns are expected to be reduced, because no exploration or production activities would occur in the deferral area, potentially reducing sources for chronic noise and disturbance impacts on subsistence resources, subsistence whaling, and other marine mammal hunting. For the communities of Barrow, Wainwright, Point Lay, and Point Hope, disturbances could affect these subsistence resources, but no resource or harvest area would become unavailable and no resource would experience an overall population decrease. Nevertheless, in the event of a large oil spill, contamination of essential whaling and other marine mammal-harvest areas would occur. Significant effects would be expected when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Oil-spill cleanup would tend to increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to them, and alter or extend the normal subsistence hunt.

IV.C.3.m. Sociocultural Systems.

This deferral provides a measure of protection to the subsistence-harvest resources within the deferred area. Space-use conflicts with subsistence activities from exploration and development would be eliminated or greatly reduced. A proportional reduction would be expected to effects on the following components of sociocultural systems:

- **Social well-being:** concerns over risk, safety and health and displacement/relocation of subsistence activities would be reduced or eliminated.
- **Subsistence values:** loss or damage to property or equipment used in wildlife harvesting and threat of present or future loss of income and/or income-in-kind from wildlife harvesting would be reduced or eliminated.
- **Community services:** effects to services which respond to effects to social well being would be reduced.
- **Nongovernmental organizations:** the issues that would motivate nongovernmental organization to become involved in the decision making process would be reduced.

The overall effects of the alternative including those from oil spills would be approximately the same for other components of sociocultural systems described in Table IV.C-2. The reduction of effects for these components would marginally reduce but would not substantially alter the overall effects to sociocultural systems.

IV.C.2.n. Archaeological Resources.

The deferral of tracts under Alternative III 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.

The potential effects of Alternative III for Sale 193 on archaeological resources are essentially the same as discussed for effects for Alternative I except that areas of possible potential will be removed in the deferral. 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. Prehistoric and historic resources both onshore and offshore will be identified by archaeological surveys and avoided or mitigated.

IV.C.2.o. Land Use Plans and Coastal Management Programs.

The potential for conflict with the Statewide standards of the ACMP and the enforceable policies of the NSBCMP are the same as for Alternative I. No conflicts are anticipated. Although Alternative III defers certain portions of the proposed sale area, activity outside the deferral areas would still be subject to the ACMP standards and NSBCMP 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 NSBCMP.

No conflicts with the statewide standards of the ACMP or with the enforceable policies of the NSBCMP are anticipated.

IV.C.2.p. Environmental Justice.

Effect levels under Alternative III (Corridor I Deferral) are expected to be reduced from those described for Alternative I (Proposed Action). Sale-specific EJ effects would derive from potential noise, disturbance, and oil-spill effects on subsistence resources, subsistence-harvest patterns, and sociocultural systems. Noise, disturbance, and oil-spill effects would be reduced under this alternative. The only substantial source of potential environmental justice related effects to coastal subsistence oriented communities on the Alaskan and Russian Chukchi Sea coastline would occur in event of a large oil spill, which could affect subsistence resources. A large oil spill could contaminate essential whaling areas and marine mammal harvest areas, and major effects could occur when impacts from contamination of the shoreline, food tainting concerns, cleanup disturbance, and disruption of subsistence practices and sociocultural systems are factored together. Such effects would represent disproportionate high adverse effects to Alaskan Natives in Chukchi Sea coastal communities and Native subsistence users in communities on the Russian Arctic Chukchi Sea coast—and would be considered significant EJ impacts. Potential adverse affects are expected to be mitigated substantially, though not eliminated.

IV.C.3. Alternative IV (Corridor II Deferral) (Agency Preferred Alternative)

IV.C.3.a. Water Quality.

Alternative IV (Corridor II Deferral) is a subset of Alternative III (Corridor I Deferral). If the assessment scenario remains the same for Alternative I, III, or IV, the actions and sources of water quality degradation do not change, but are only sited elsewhere. The deferral areas may avoid localized discharges to marine water; however, the removal of the deferred lease blocks would not significantly affect the marine water quality either negatively or beneficially. Compliant postlease activities do not pose a significant degree of risk to water quality (Sec. IV.C.1.a). While the selection of this alternative decreases the opportunity of discovering a commercial field, the resources in this area could still be affected by a large oil spill that may occur elsewhere in the sale area.

IV.C.3.b. Air Quality.

Alternative IV would have lower potential air quality impacts to the adjacent onshore area than Alternative I, but not as much as under Alternative III. Tracts available for leasing are nearer the shore than under Alternative III, but not as close as under Alternative I. The difference in air quality impact, however, would be negligible.

IV.C.3.c. Lower Trophic-level Organisms.

The main effects on lower trophic-level organisms would be related to possible summer exploration discharges on nearshore tracts, to possible production discharges during the winter over the life of the field, to benthic disturbance during the assumed burial of several hundred miles of production pipelines, and to oil spills that could contact the coastline (Sec. IV.C.1.c). The deferral of 795 whole or partial blocks near the coast would reduce mainly the effect of possible discharges on nearshore tracts; the other effects would stay about the same. Overall, the effects of Alternative IV on these organisms still would be local but moderate, as stated for Alternative I in Section IV.C.1.c. Specifically, the disturbance effect of 14 anticipated exploratory wells probably would be low unless the wells were located near any special biological communities; regardless, the MMS would review further any installation proposals and could require surveys. Exploratory discharges during summer probably would lead to low effects in offshore locations and to slightly greater local effects in the coastal tracts. Water circulation under the winter ice cover is slow, so we assume that produced water would be reinjected; regardless, the local effects of produced-water discharge for the life of the field probably would be moderate, but any such discharge proposals would be reviewed in detail by MMS and USEPA. We assume that an extensive system of buried pipelines would radiate from a central production platform and that a single pipeline would extend to shore. This pipeline installation would probably disturb 1,000-2,000 acres of typical benthic organisms that would slowly recolonize the area within a decade, leading overall to a major level of effect. The disturbance effects would be assessed and possibly monitored by the MMS and U.S. Army Corps of Engineers. The effects of an alternative to production pipelines—the transportation of produced oil in vessels—would pose a much greater spill risk to the coast adjacent to the Spring Lead System. The OSRA model estimates a 35% chance of one or more large spills $\geq 1,000$ bbl occurring during the production life of the fields, but a 1% chance of one or more large oil spills occurring and contacting the U.S. Chukchi coastline within three days. If a large oil spill did contact this coastline, the oil probably would persist in a few of the tidal and subtidal sediments for a couple decades, leading to a local but moderate effect on the few intertidal organisms. The chance of one or more large spills occurring and contacting the Chukchi sea coastline increases to 5% within 30 days, demonstrating the advantages of requirements for rapid response capability. During the abandonment phase, we assume that the extensive pipeline system would be cleaned, plugged, and abandoned in place. Overall, the level of effect of Alternative IV on lower trophic-level organisms with standard mitigation would be moderate, and the level with proposed requirements for rapid spill response capability would be minor.

IV.C.3.d. Fish Resources.

This alternative has a smaller deferral area than Alternative III. The deferral area would be in the form of a corridor on the shoreward margin of the proposed lease-sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects farther away from important fish habitats. The increased distance between offshore development and coastal fish habitats also would conceivably decrease the percent chance of spilled oil contact, increase weathering of spilled oil prior to contact, and increase available spill response time. This alternative would provide the same types of net resource benefits as Alternative III, but at a reduced level.

IV.C.3.e. Essential Fish Habitat.

Alternative IV (Corridor II Deferral) includes an approximately 35 km (21 mi) setback deferral area (prohibiting leasing and potential subsequent exploration and production activities in specific areas) along the Chukchi Sea shoreline. This alternative would employ standard mitigation measures described in Section IV.C.1.e(4) to avoid or limit the potential impacts to EFH.

As explained under the analysis for Alternative III (Sec. IV.C.2.e), a deferral would provide more protection for coastal and marine fish habitat by moving drilling and construction noise disturbances and water quality impacts (exploration and production platform discharges, turbidity) farther away from the Chukchi Sea coastline. Many of the potential effect categories remain the same as the Proposed Action, but those anticipated impacts would be lower due to the setback from the coast.

Other potential resource benefits could occur if a large oil spill occurred, because the increased distance to the shoreline conceivably reduces the percent chance that oil would make contact with sensitive coastal resources and the increased time required for oil to travel this greater distance would conceivably allow for a more effective response from spill-response depots. One negative aspect of deferrals is the potential for increased pipeline distances. Increased pipeline distances would increase the potential for a pipeline spill and would result in larger pipeline construction impacts. Overall, there are greater net ecological benefits to EFH that would accrue from deferral of Corridor II under Alternative IV compared to Alternative I. These benefits, however, are not as great as those achieved by Alternative III, because Alternative III contains a larger deferral area.

IV.C.3.f. Threatened and Endangered Species.

IV.C.3.f(1) Threatened and Endangered Marine Mammals. The assessment of this alternative is essentially identical to the assessment for Alternative III (Corridor I Deferral). This alternative would also preclude the development, production, and abandonment of oil and gas activities in the lease blocks within Corridor II, thereby reducing (but not as much as Alternative III) potential conflicts between migrating bowhead whale populations, bowhead-whale subsistence hunters, and offshore oil and gas operations. Seismic surveys (if permitted by the MMS, per 30 CFR Part 251–Geological and Geophysical Explorations of the Outer Continental Shelf) for the exploration of oil and gas resources in the Chukchi Sea Proposed Action Area would be allowed to continue within the corridor.

Differences in noise and oil-spill effects to bowhead whales from this deferral compared to Alternative I (Proposed Action) and Alternative III (Corridor I Deferral) are difficult to quantify, but qualitatively can be described. While the selection of this alternative decreases the opportunity of discovering a commercial field and the number of oil spill launch sites, the resources in and adjacent to this area still could be adversely affected by a large oil spill originating from a production site and/or pipeline located elsewhere in the sale area. Therefore, the impacts of oil spills and industrial noise on threatened and endangered marine mammals, as described and analyzed in sections IV.C.1.f apply.

The deletion of this area from the lease sale would move sources of industrial noise and sources of crude oil farther offshore and away from the spring-lead system, thus somewhat reducing the likelihood of spring bowhead whale encounters with industrial noise. It would not, however, substantially reduce the probability of crude oil contacting the spring-migratory route because: (1) pipelines constructed through the spring-migratory route in order to transport oil to shore-based processing facilities could leak; and, (2) oil spill trajectory models indicate that depending on oceanographic and weather conditions, oil spilled outside Corridor II could be transported into the spring-migratory route. But because this alternative reduces the number of potential oil spill launch sites and their locations are farther away from the spring-migratory route, any spill that would occur would take longer to reach and enter the spring-migratory route, thus allowing more time to respond to the spill (but not as much response time afforded by Alternative III). Because fall migrating bowhead whales are not expected to use the deferred area, fall bowhead encounters with oil and gas-related industrial noise and oil spills would be the same as for the base condition (Alternative I (Proposed Action)).

IV.C.3.f(2) Threatened and Endangered Marine and Coastal Birds. This alternative has a smaller deferral area than Alternative III. The deferral area would be in the form of a corridor on the shoreward margin of the proposed lease-sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects farther away from bird habitats, particularly staging and molting areas, important to spectacled and Steller's eiders (threatened species) and Kittlitz's murrelet (a candidate species). Habitat alterations and surface developments would occur outside designated critical habitat for the spectacled eider. The increased distance between offshore development and coastal bird habitats would conceivably decrease the percent chance of one or more large spills contacting important bird habitats,

increase weathering of spilled oil prior to contact, and increase available spill-response time. This alternative would provide the same types of net resource benefits as Alternative III, but at a reduced level.

IV.C.3.g. Marine and Coastal Birds.

This alternative has a smaller deferral area than Alternative III. The deferral area would be in the form of a corridor on the shoreward margin of the proposed lease-sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects farther away from important bird habitats. The increased distance between offshore development and coastal bird habitats would conceivably decrease percent chance of one or more spills contacting important bird habitats, increase weathering of spilled oil prior to contact, and increase available spill-response time. This alternative would provide the same types of net resource benefits as Alternative III, but at a reduced level.

IV.C.3.h. Other Marine Mammals.

This alternative would provide a deferral area smaller than Alternative III and provide greater net resource benefits to marine mammals than Alternative I. This deferral area would be in the form of a corridor on the shoreward margin of the proposed lease-sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects farther away from important coastal habitats. However, because of the lack of data on marine mammal distributions and habitat use in offshore areas of the Chukchi Sea, it is uncertain what the level of effects would be in offshore areas. The increased distance between offshore development and coastal habitats would conceivably decrease the percent chance of one or more large oil spills contacting nearshore habitats, increase weathering of spilled oil prior to contact, and increase available spill-response time.

IV.C.3.i. Terrestrial Mammals.

This alternative would provide a deferral area smaller than Alternative III and would be in the form of a corridor on the shoreward margin of the proposed lease-sale area. The primary benefit of this corridor is that it would move sources of potential adverse effects farther away from important coastal habitats. The increased distance between offshore development and coastal habitats would conceivably decrease the percent chance of one or more large oil spills contacting shore, increase weathering of spilled oil prior to contact, and increase available spill-response time.

IV.C.3.j. Vegetation and Wetlands.

This alternative would have similar impacts on vegetation and wetlands as would Alternative I (Proposed Action), because there is no difference in the activities projected onshore. See Section IV.C.1.j(1) for more details on the impact analysis.

IV.C.3.k. Economy.

The economic effects of Alternative IV would be the same as Alternative I. For purposes of economic analysis, we assume that the full exploration and development scenario for each of the deferral alternatives would occur as for Alternative I. That is, the OCS activity would take place in a different area and be the same for each deferral alternative as for Alternative I.

IV.C.3.l. Subsistence-Harvest Patterns.

The Corridor II deferral is essentially a subset of the Corridor I deferral and would exclude 795 whole or partial blocks along the shoreward edge of the sale area. This alternative was developed by MMS in response to NMFS' most recent Biological Opinion for the Chukchi Sea that suggested that the lease blocks within 25 mi of shore be deferred from the lease sale to protect the nearshore spring lead system and reduce impacts to spring migrating bowhead whales and other marine mammals. It would serve to protect subsistence-whaling areas important to the communities of Barrow, Wainwright, Point Lay, and Point Hope. This alternative would afford more protection to nearshore subsistence resources, habitats, and hunting areas than the Proposed Action but less than Alternative III.

This deferral would move the shoreward boundary of the lease sale 25 mi offshore, prohibiting leasing, exploration, development, and production activities; thus, moving the zone for potential noise, disturbance, and oil-spill effects farther away from the Chukchi Sea spring lead system, nearshore coastal waters, and onshore habitats. In this way, subsistence resources, habitats and hunting areas would be afforded more protection from potential impacts. The chance of spring bowhead whale encounters with industrial noise likely would be reduced. Reductions in noise, disturbance, and oil-spill effects from this deferral would provide the same types of resource benefits as described in Alternative III but at a reduced level, because the area deferred is smaller; it is difficult to quantify differences in effects reductions between these two alternatives.

For the Proposed Action (Alternative I), the percent chance of one or more large spills occurring over the production life of the project is 40%; with this alternative, the percent chance is reduced to 35%. Because potential launch points for oil spills would move seaward, thus, increasing the time for spilled oil to weather, the time to mount oil-spill response and potentially reducing contact and impact. Resources in this area could still be affected by a large oil spill that occurred elsewhere in the sale area, and pipeline routes from farther offshore areas would still cross deferred areas. There would be no reduction in effects from potentially seismic surveys in the sale area as seismic survey permitting is non-lease specific.

Effects on subsistence-harvest patterns are expected to be reduced because no exploration or production activities would occur in the deferral area, potentially reducing sources for chronic noise and disturbance impacts on subsistence resources, subsistence whaling, and other marine mammal hunting. For the communities of Barrow, Wainwright, Point Lay, and Point Hope, disturbances could affect these subsistence resources, but no resource or harvest area would become unavailable and no resource would experience an overall population decrease. Nevertheless, in the event of a large oil spill, contamination of essential whaling and other marine mammal harvest areas would occur. Significant effects would be expected when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together. Oil-spill cleanup would tend to increase these effects. Cleanup disturbances could displace subsistence species, alter or reduce subsistence-hunter access to them, and alter or extend the normal subsistence hunt.

IV.C.4.m. Sociocultural Systems.

Alternative IV provides a measure of protection to the subsistence-harvest resources within the deferred area. Space-use conflicts with subsistence activities from exploration and development would be eliminated or greatly reduced. A proportional reduction would be expected to effects on the following components of sociocultural systems:

- **Social well-being:** concerns over risk, safety and health and displacement/relocation of subsistence activities would be reduced or eliminated.
- **Subsistence values:** loss or damage to property or equipment used in wildlife harvesting and threat of present or future loss of income and/or income-in-kind from wildlife harvesting would be reduced or eliminated.
- **Community services:** effects to services which respond to effects to social well being would be reduced.
- **Nongovernmental organizations:** the issues that would motivate nongovernment organization to become involved in the decision making process would be reduced.

The overall effects of the alternative including those from oil spills would be approximately the same for other components of sociocultural systems described in Table IV.C-1. The reduction of effects for these components would marginally reduce but would not substantially alter the overall effects to sociocultural systems.

IV.C.3.n. Archaeological Resources.

The deferral of tracts under this alternative 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 Alternative I.

The potential effects of Alternative IV for Sale 193 on archaeological resources are essentially the same as discussed for Alternative I, except that areas of possible potential will be removed in the deferral. 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. Prehistoric and historic resources both onshore and offshore will be identified by archaeological surveys and avoided or mitigated.

IV.C.3.o. Land Use Plans and Coastal Management Programs.

The potential for conflict with the Statewide standards of the ACMP and the enforceable policies of the NSBCMP are the same as for Alternative I. No conflicts are anticipated. Although Alternative IV defers certain portions of the proposed sale areas, activity outside the deferral areas would still be subject to the ACMP standards and NSBCMP 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 NSBCMP.

No conflicts with the Statewide standards of the ACMP or with the enforceable policies of the NSBCMP are anticipated.

IV.C.3.p. Environmental Justice.

Effect levels under Alternative IV are expected to be reduced from those described for Alternative I. Sale-specific EJ effects would derive from potential noise, disturbance, and oil-spill effects on subsistence resources, subsistence-harvest patterns, and sociocultural systems. Reductions in noise, disturbance, and oil-spill effects from this deferral would provide the same types of resource benefits as described in Alternative III but at a reduced level because the area deferred is smaller. And, it is difficult to quantify differences in effects reductions between these two alternatives. The only substantial source of potential EJ-related effects to coastal subsistence oriented communities on the Alaskan and Russian Chukchi Sea coastline would occur in event of a large oil spill, which could affect subsistence resources. A large oil spill could contaminate essential whaling areas and marine mammal harvest areas, and major effects could occur when impacts from contamination of the shoreline, food tainting concerns, cleanup disturbance, and disruption of subsistence practices and sociocultural systems are factored together. Such effects would represent disproportionate high adverse effects to Alaskan Natives in Chukchi Sea coastal communities and Native subsistence users in communities on the Russian Arctic Chukchi Sea coast—and would be considered significant environmental justice impacts. Potential adverse effects are expected to be mitigated substantially, though not eliminated.

IV.C.4. Alternative A (Exploration Seismic Surveys within the Entire Proposed Sale 193 Area).

The Proposed Action for seismic surveying is to permit both prelease and postlease exploration seismic surveys within the entire proposed Sale 193 area. All permitted seismic surveys would be subject to the standard stipulations for G&G permit activities (Sec. II.B.4), the measures to mitigate seismic-surveying effects (Sec. II.B.4.a), and the mitigation and monitoring requirements of the selected alternative (Alternative 6) from the *Final Programmatic Environmental Assessment (PEA) Arctic Ocean Outer Continental Shelf Seismic Surveys - 2006*, dated June 2006 (USDOI, MMS, 2006a) (Sec. II.B.4.b). Exploration seismic surveys with requirements are included in the scenarios for Sale 193 Alternatives I, III, and IV. The potential effects of such seismic surveys are evaluated in the impact analyses presented in Section IV.C.1.

IV.C.5. Alternative B (Prohibit Pre-Sale 193 Exploration Seismic Surveys in the Corridor II Deferral Area).

This alternative to the Proposed Action for seismic surveys (Alternative A) would prohibit pre-Sale 193 exploration seismic surveys in the 795 whole or partial blocks in Corridor II Deferral area (Alternative IV) along the coastward edge of the proposed Sale 193 area. The Corridor II Deferral area was developed from the recommended conservation measures in the 1987 Biological Opinion from NMFS. The southern end of the corridor was expanded to encompass a portion of the Ledyard Bay Critical Habitat Area that lies within

the proposed Sale 193 area. Prohibiting pre-Sale 193 seismic surveys in this area would eliminate potential direct impacts from seismic surveys in this area during 2007, including the presence of seismic-source vessels and potential space-use conflicts. Prohibiting pre-Sale 193 seismic surveys in this area would reduce potential noise disturbance to coastal resources and activities during 2007. These potential impacts are described in the Proposed Action analyses in Section IV.C.1.

Prohibiting pre-Sale 193 seismic surveys in this area would defer seismic surveys in this area until the Sale 193 decisions are made. If this area is deferred from leasing in Sale 193, then little seismic surveying would be expected to be proposed in this area. Some of the original Corridor II Deferral Area already has been deferred from leasing in the 2007-2012 5-Year Program. If Corridor II is deferred from Sale 193, no ancillary activities would occur in the area.

Prohibiting pre-Sale 193 seismic surveys in this area would defer seismic surveys in this area until the NMFS/MMS Seismic Survey Programmatic EIS and a record of decision have been completed.

IV.D. Unavoidable Adverse Effects.

This section summarizes the unavoidable adverse effects of Alternative I for Lease Sale 193 and exploration seismic activities. Unavoidable adverse impacts could occur during exploration, development, and production. Many of the adverse effects identified in Sections IV and V of this EIS would occur only if a large ($\geq 1,000$ bbl) oil spill occurred; however, such an event is unlikely to happen. The effects of large oil spills are discussed in Section IV.A.4.a. and IV.A.4.b but are not included in this analysis, because they are not expected to happen. The following analyses identify unavoidable adverse effects that are likely to occur if Lease Sale 193 is held as scheduled and results in exploration, development, and production.

IV.D.1. Water Quality.

A wide range of water quality degradation could occur as a result of oil activities associated with nonpoint-source and point-source discharges, construction activities, normal operational activities, and accidental hydrocarbon discharges due to spills, blowouts, noncompliant operational activities and/or permitted processes, and chronic small-volume spills. The proportions and amounts of discharged wastes can change considerably during the life cycle of OCS postlease exploration to development and operations activities. The impacts to water quality resulting from oil and gas exploration and development depend on contact of oil and gas generated waste stream with marine waters; and waste stream management.

Oil and gas development projects resulting from the lease sale may cause small, localized increases in the concentrations of pollutants to water quality (Sec. IV.C.1.a Water Quality). Effects on local water quality are expected to be low, while regional effects are expected to be very low.

To minimize or eliminate the impacts to water quality resulting from postlease oil and gas activities, mitigations in the form of permitted regulatory programs, engineered mitigations, and operational procedures may be employed. The extent that facilities are constructed and sited to minimize adverse environmental impacts, especially from an oil spill, diminishes unavoidable adverse effects normally associated with such activities. It is anticipated that any discharges of waste to marine waters will conform with existing regulatory programs and requirements; and to the MMS policies and management programs.

The exploration and development scenario supposes that production slurry (oil, gas, water) will be gathered on the central platform where gas and water will be separated and the produced water re-injected. Shallow injection wells will handle these waste waters and treated drill cuttings. Gas recovered with oil production will be used as fuel for the facility or reinjected into the main reservoir to increase oil recovery. These operations and practices are but two of many mitigations that may minimize and/or eliminate unavoidable adverse effects to water quality.

IV.D.2. Air Quality.

Oil and gas development projects resulting from the sale would cause small, localized increases in the concentrations of criteria pollutants. Concentrations would be within the PSD Class II limits and National Ambient Air Quality Standards (NAAQS), and would be below the level considered harmful to public health and welfare.

IV.D.3. Lower Trophic-Level Organisms.

As explained in Sections IV.C.1.c(4)(a) and (c), we assume that an extensive system of buried pipelines would radiate from a central production platform and that a single pipeline would extend to shore. The pipeline installation probably would disturb 1,000-2,000 acres of typical benthos for less than a decade. However, we assume that during the abandonment phase the pipeline system would be cleaned, plugged, and abandoned in place, at which time it would become a public responsibility. Bond requirements could be increased for Chukchi developers, making the bond size commensurate with the estimated financial obligations associated with the careful construction and abandonment of pipelines. Overall, the effect on lower trophic-level organisms with standard mitigation would be local but moderate, and the level would be minor with larger development bonds.

IV.D.4. Fish Resources.

Accidental spills are viewed as unavoidable adverse effects. As presently described, the Proposed Action (leasing, seismic activity, and exploratory drilling) and subsequent development would be expected to result in unavoidable adverse effects on fish resources in the proposed lease sale area. The majority of these adverse effects would arise from a large spill that could result in a level of mortality that could eliminate reproduction and subsequent recruitment from contaminated habitats along tens of miles of coastline for extended periods of time. Some populations could recover to preimpact levels in fewer than 3 generations once habitats have recovered. Other populations, particularly discrete runs of salmon, could be eliminated and would only recover by strays from unaffected populations colonizing the vacant streams, a process that could take decades.

IV.D.5. Essential Fish Habitat.

Accidental spills are viewed as unavoidable adverse effects. As presently described, the Proposed Action (leasing, seismic activity, and exploratory drilling) and development would be expected to have unavoidable adverse effects to EFH. These adverse effects would arise from a large spill that could contaminate fish habitats and eliminate discrete runs of salmon. Recovery of these populations would only occur if strays from unaffected populations colonized the vacant streams, a process that could take decades.

IV.D.6. Threatened and Endangered Species.

IV.D.6.a. Threatened and Endangered Marine Mammals.

Oil and gas activities within the Proposed Action area may have unavoidable effects on bowhead whales that move into the area. Bowhead whales exposed to unmitigated, uncontrolled noise and other forms of disturbance associated with routine activities (i.e., noise due to seismic surveys, vessel activity, aircraft overflights, drilling activities, or construction activities) likely would experience temporary, nonlethal effects, such as behavioral changes. 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.

If a large oil spill were to occur during the period that bowhead whales were in the Proposed Action Area, it is likely that they would be contacted by crude oil for brief periods of time. Such contact could cause health problems, changes in behavior, affect feeding, and in the extreme case, cause mortalities.

Construction-related and disturbance-related effects could be mostly avoided through seasonal restrictions on certain activities and on avoidance of disturbance activities in areas with known aggregations of

bowhead whales. Impacts could also be avoided through voluntary compliance with appropriate stipulations and Information to Leasees clauses. However, MMS considers most disturbances of bowhead whales associated with routine activities avoidable and expects all activities to comply with prohibitions against take, as defined by the Endangered Species Act.

IV.D.6.b. Threatened and Endangered Marine and Coastal Birds.

Accidental spills are viewed as unavoidable adverse effects. As presently described, the proposed action (leasing, seismic activity, and exploratory drilling) and development would be expected to have unavoidable adverse effects on threatened and endangered birds in the proposed lease sale area. These adverse effects would arise from a large spill and/or chronic small-volume spills that could result in substantial mortality; chronic vessel, platform, and aircraft disturbance; direct impacts to critical habitat and other nesting, foraging, and molting habitats during construction/operation of a platform, shore-base, pipeline, and maintenance road; mortality from collisions with vessels and aircraft; and indirect impacts from increased predator populations and increased hunting access. Most of these adverse effects could be lessened or avoided by mitigation measures.

IV.D.7. Marine and Coastal Birds.

Accidental spills are viewed as unavoidable adverse effects. As presently described, the proposed action (leasing, seismic activity, and exploratory drilling) and subsequent development would be expected to have unavoidable adverse effects on coastal and marine birds in the proposed lease sale area. These adverse effects would result from a large spill and/or chronic small-volume spills that could result in a level of mortality that would substantially reduce or eliminate specific breeding colonies of murre, puffins, and black guillemots along the Chukchi Sea coast. An oil spill entering Kasegaluk Lagoon or Peard Bay could impact tens of thousands of birds or contaminate important breeding, foraging, or molting habitats for years. Additional impacts would arise from chronic vessel, platform, and aircraft disturbance; direct impacts to nesting, foraging, and molting habitats during construction/operation of a platform, shore-base, pipeline, and maintenance road; mortality from collisions with vessels and aircraft; and indirect impacts from increased predator populations and increased hunting access. Most of these adverse effects could be lessened or avoided by mitigation measures.

IV.D.8. Other Marine Mammals.

Accidental spills are viewed as unavoidable adverse effects. As presently described, the Proposed Action (leasing, seismic activity, and exploratory drilling) and subsequent development would be expected to result in unavoidable adverse effects on marine mammals in the proposed lease-sale area. The majority of these adverse effects would arise from a probable large spill that could result in substantial mortalities to marine mammal aggregations near the coast (polar bears, walrus, beluga whales). Noise and disturbance from exploration, development, and production activities also could adversely affect marine mammals' habitat use, particularly that of whales, in the project area.

IV.D.9. Terrestrial Mammals.

Accidental spills are viewed as unavoidable adverse effects. As presently described, the Proposed Action (leasing, seismic activity, and exploratory drilling) and subsequent development might be expected to result in unavoidable adverse effects on terrestrial mammals in the proposed lease sale area. The majority of these adverse effects would arise from a probable large spill that could result in a level of mortality that could eliminate fish reproduction and subsequent recruitment from contaminated habitats along tens of miles of coastline for extended periods of time. Some populations could recover to preimpact levels in fewer than 3 generations, once habitats have recovered. Other populations, particularly discrete runs of salmon, could be eliminated and would recover only by strays from unaffected populations colonizing the vacant streams, a process that could take decades. Such impacts would directly affect the grizzly bear populations of the Chukchi coast, which rely on salmon runs as a critical portion of their seasonal nutrition.

IV.D.10. Vegetation and Wetlands.

Onshore-pipeline and road-construction effects on wetlands are expected to be unavoidable. The effects of gravel fill, thermokarst, road dust, and some small oil spills are unavoidable. However, these damaging effects are expected to be local (within 100 m of the pipeline-road corridor). Less than 1% of the coastal plain wetlands of the North Slope is likely to be unavoidably affected.

IV.D.11. Economy.

Unavoidable effects on the economy generally are considered positive rather than adverse but some people consider any one or a combination of them as adverse. Production is projected to generate increases above the levels without Alternative 1 as follows: North Slope Borough Property taxes, \$0.3-\$0.5 million; annual revenues to the State of Alaska, \$2-\$25 million; annual revenues to the Federal Government, \$50-\$700 million; 2-22 direct oil industry jobs for workers residing in the North Slope Borough; 215-1,054 residing in Southcentral Alaska; and an additional 50% of the direct jobs in indirect and induced jobs.

IV.D.12. Subsistence-Harvest Patterns.

Seals, walrus, caribou, fish, birds, polar bears, beluga whales and especially bowhead whales are important subsistence resources. Noise and disturbance from exploration, development, and production activities could affect subsistence resources periodically in the communities of Barrow, Wainwright, Point Lay, and Point Hope. Additionally, disturbance could cause potential short-term but adverse effects to long-tailed ducks and some eider populations. Oil-spill incidents that are unlikely but unavoidable could lead to the localized, direct loss of small numbers of beluga whales, seals, walrus, caribou, fish, birds, and polar bear; and could lead to the elimination of subsistence harvests based 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. Some of the risks from oil spills to bowheads and other marine mammals can be mitigated.

IV.D.13. Sociocultural Systems.

Effects to governmental functions (land use, planning and zoning) and subsistence values that result from the placement of onshore infrastructure including the support base near Wainwright, the onshore pipeline, and portions of the offshore pipeline are not avoidable.

IV.D.14. 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.D.15. Land Use Plans and Coastal Management Programs.

To the extent that facilities are constructed and sited to minimize adverse environmental and social effects, especially from an oil spill, conflicts with the ACMP standards and the enforceable policies of the North Slope Borough are avoidable. It is anticipated that activities will conform with existing land use plans and to the policies of local, State, and Federal coastal zone management programs.

IV.D.16. Environmental Justice.

Sale-specific environmental justice effects would derive from potential short-term noise and disturbance effects on subsistence resources, subsistence-harvest patterns, and sociocultural systems. Noise and disturbance from exploration, development, and production activities could affect subsistence resources periodically in the communities of Barrow, Wainwright, Point Lay, and Point Hope. The only substantial source of potential environmental justice related effects to coastal subsistence oriented communities on the Alaskan and Russian Chukchi Sea coastline would occur in event of a large oil spill, which could affect subsistence resources. Oil-spill incidents that are unlikely but unavoidable could contaminate essential whaling areas and marine mammal harvest areas, and major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together.

IV.E. Relationship Between Local-Short-Term Uses and Maintenance and Enhancement of Long Term Productivity.

In this section, the short-term effects and uses of various components of the environment of the Chukchi Sea Lease Sale 193 area are related to the 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 preparation activities (such as seismic-data collection and exploration drilling) of oil and gas development and ending with the restoration of natural environmental balances.

In general, “short term” refers to the useful lifetime of the Proposal, but some shorter term uses and effects are considered. “Long term” refers to the time beyond the life of the Proposed Action. The overall life of the Proposal under the hypothetical scenario is estimated to be 30 years, including 5 years of exploration (2009-2015), a 23-year period of development and production (2019-2044), and a 2-year decommissioning (2044-2046). “Short term” refers to the total duration of the project from exploration to decommissioning 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 exploration, development, and early production) and are reduced by the mitigation measures discussed in Section II.F that are considered part of the Proposed Action and Alternatives.

Consumption of offshore oil would be a long-term use of nonrenewable resources. Economic, political, and social benefits would accrue from the availability of oil. Most benefits would be short term and would decrease the Nation’s dependency on oil imports. Benefits would accrue to the North Slope Region.

Alternatives to the Proposed Action—such as cancellation of the lease sales (the No Lease Sale Alternative [II]) and the deferral alternatives (Alternatives III and IV)—would reduce to varying degrees both the long- and short-term environmental effects as well as the long- and short-term energy benefits.

The overall long-term effect of Sale 193 would be a small reduction in the productivity of the environment, as described in the following paragraphs.

IV.E.1. Water Quality.

Oil and gas development projects resulting from the lease sale may cause small, localized increases in the concentrations of pollutants to water quality (Sec. IV.C.a. Water Quality). Effects on local water quality are expected to be low, while regional effects are expected to be very low. These effects are considered to be temporary in nature; diminishing and precipitating over a small period of time after the discharges are stopped.

IV.E.2. Air Quality.

Oil and gas development projects resulting from the sale would cause small, localized increases in the concentrations of criteria pollutants. Adverse effects from corresponding air pollution resulting from oil and gas development would be a short-lived. Although the pristine air quality of the project area may be impaired temporarily and locally, the long-term adverse effects would be insignificant.

IV.E.3. Lower Trophic-Level Organisms.

As stated in Sections IV.C and IV.D, we assume that an extensive system of buried pipelines would probably disturb the benthos for less than a decade, leading to a local but moderate level of effect. If an oil spill contacted the shoreline, the oil probably would persist in a few of the tidal and subtidal sediments for a couple decades, leading also to a local but moderate lower-trophic impact. The chance of large spills contacting the coastline increases to 6% within 30 days, demonstrating the advantages of requirements for rapid response capability. Overall, the effect on lower trophic-level organisms with standard mitigation would be local but moderate, and the level would be minor with proposed requirements for rapid spill response capability.

IV.E.4. Fish Resources.

As presently described, the proposed action (leasing, seismic activity, and exploratory drilling) would be expected to have minimal short-term adverse effects on fish resources in the proposed lease sale area. Subsequent development could result in long-term adverse effects to fish resources. The majority of these impacts would arise from a large spill that could result in a level of mortality that could eliminate reproduction and subsequent recruitment from contaminated habitats along tens of miles of coastline for extended periods of time. Some populations could recover to pre-impact levels in fewer than 3 generations once habitats have recovered. Other populations, particularly discrete runs of salmon, could be eliminated and would only recover by strays from unaffected populations colonizing the vacant streams, a process that could take decades.

IV.E.5. Essential Fish Habitat.

As presently described, the proposed action (leasing, seismic activity, and exploratory drilling) would be expected to have minimal short-term adverse effects on Essential Fish Habitat (EFH) in the proposed lease sale area. Subsequent development could result in long-term adverse effects to EFH. The majority of these impacts would arise from a large spill that could contaminate fish habitats and eliminate discrete runs of salmon. Recovery of these populations would only occur if strays from unaffected populations colonized the vacant streams, a process that could take decades.

IV.E.6 Threatened and Endangered Species.

IV.E.6.a. Threatened and Endangered Marine Mammals.

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 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 operations.

IV.E.6.b. Threatened and Endangered Marine and Coastal Birds.

As presently described, the proposed action (leasing, seismic activity, and exploratory drilling) would be expected to have adverse short-term effects on threatened and endangered birds in the proposed lease sale area. The majority of these negative effects would result from frequent vessel, drillship, and aircraft disturbance to molting eiders, collisions with vessels and aircraft, direct seafloor impacts to spectacled eider critical habitat, and potential contamination of eider foraging habitats.

Subsequent development could result in long-term adverse effects to threatened and endangered birds. The majority of these impacts would arise from a large spill and/or chronic small-volume spills that could result in a level of mortality that would jeopardize the continued existence of the spectacled eider population on the North Slope. Additional impacts would arise from chronic vessel, platform, and aircraft disturbance; direct impacts to critical habitat and other nesting, foraging, and molting habitats during construction/operation of a platform, shore-base, pipeline, and maintenance road; mortality from collisions

with vessels and aircraft; and indirect impacts from increased predator populations and increased hunting access. Most adverse effects can be avoided or minimized with conservation measures.

IV.E.7. Marine and Coastal Birds.

As presently described, the proposed action (leasing, seismic activity, and exploratory drilling) would be expected to have moderate short-term adverse effects on coastal and marine birds in the proposed lease sale area. These negative effects would result from frequent vessel, drillship, and aircraft disturbance to periodic disturbance and/or displacement of foraging or molting birds. Additional impacts would be associated with collisions with vessels and aircraft.

Subsequent development could result in long-term adverse effects to marine and coastal birds. The majority of these impacts would arise from a large spill and/or chronic small-volume spills that could result in a level of mortality that would substantially reduce or eliminate specific breeding colonies of murre, puffins, and black guillemots along the Chukchi Sea coast. An oil spill entering Kasegaluk Lagoon or Peard Bay could impact tens of thousands of birds or contaminate important breeding, foraging, or molting habitats for years. Additional impacts would arise from chronic vessel, platform, and aircraft disturbance; direct impacts to nesting, foraging, and molting habitats during construction/operation of a platform, shore-base, pipeline, and maintenance road; mortality from collisions with vessels and aircraft; and indirect impacts from increased predator populations and increased hunting access. Most adverse effects can be avoided or minimized with conservation measures.

IV.E.8. Other Marine Mammals.

As presently described, the Proposed Action (leasing, seismic activity, and exploratory drilling) would be expected to have moderate, short-term adverse effects on marine mammals in the proposed lease-sale area. These negative effects would result from frequent vessel, drillship, and aircraft disturbance to periodic disturbance and/or displacement of animals.

Subsequent development could result in significant, adverse effects to marine mammals. The majority of these impacts would arise from a probable large spill. Additional impacts would arise from chronic vessel, platform, and aircraft disturbance; and direct impacts to habitats during construction/operation of platforms, shore-bases, and pipelines.

IV.E.9. Terrestrial Mammals.

As presently described, the Proposed Action (leasing, seismic activity, and exploratory drilling) would be expected to have moderate, short-term adverse effects on terrestrial mammals in the proposed lease-sale area. These negative effects would result from frequent aircraft disturbance to periodic disturbance and/or displacement of animals from important habitats.

Subsequent development could result in significant adverse effects to terrestrial mammals. The majority of these impacts would arise from a probable large spill. Additional impacts would arise from chronic vehicle and aircraft disturbance; direct impacts to habitats during construction/operation of shore bases, pipelines, and maintenance roads; and indirect impacts from increased hunting access.

IV.E.10. 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.E.11. Economy.

With respect to local short-term uses and maintenance and enhancement of long-term productivity, the following would occur for the economy. Increased revenues, employment, and income generated by

Alternative I would provide short-term energy and, perhaps, provide time either for the development of long-term alternative-energy sources or substitutes for petroleum. Domestic production of petroleum would decrease the nation's dependency on oil imports. If additional petroleum resources were discovered and developed, the Alternative I production system would enhance extraction. However, the consumption of this resource would be a relatively short-term use of non-renewable energy resources.

IV.E.12. 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.E.13. Sociocultural Systems.

Short-term effects on social systems, cultural values, and institutional organization are not expected to have long-term adverse consequences. Effects to governmental functions (land use, planning and zoning) and subsistence values that result from the placement of onshore infrastructure including the support base near Wainwright, the onshore pipeline, and portions of the offshore pipeline are not expected to continue past the end of the project.

IV.E.14. 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.E.15. Land Use and Coastal Management Programs.

Land use changes would occur at shore-based sites and along onshore pipeline routes. In these potentially affected areas, short-term changes would include a relative shift in land use from subsistence-based activities to industrial activities throughout the life of the proposed action. Land use changes would be short-term if use of the land reverted to previous uses after production ceased. Long-term effects, however, could result if use of facilities continued after oil and gas production ceased. Potential users could be other resource developers or area residents who had become accustomed to the convenience of using existing facilities, such as onshore roads.

IV.E.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 event of a large oil spill.

IV.F. Irreversible and Irretrievable Commitment of Resources.

Irreversible and irretrievable commitment of resources refers to impacts or losses to resources that cannot be reversed or recovered. This section discusses the irreversible and irretrievable commitment of resources that could occur if Sale 193 is held as scheduled and results in exploration, development, and production. Many of the adverse 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 oil spills are discussed in Sections IV.A.4 and are included in this analysis.

IV.F.1. Water Quality.

No irreversible or irretrievable effects on water quality are expected from the Proposed Action.

IV.F.2. Air Quality.

The highest pollutant concentrations emitted from oil and gas development projects would be confined to areas within a short range of the facility. Because of shifting winds and changing meteorological conditions, the pollutant concentrations at any one particular location would be variable, with higher concentrations lasting for a short duration (typically a few hours up to a day), and would reoccur throughout the life of the project. The predicted pollutant concentrations would be within the National Ambient Air Quality Standards (NAAQS) set by the Environmental Protection Agency and, thus below the level considered harmful to public health and welfare. No adverse impacts would be expected.

IV.F.3. Lower Trophic-Level Organisms.

Seafloor disturbance would be irreversible in special biological communities such as kelp communities on hard substrate and/or any “pockmark” communities around methane seeps on the deep Chukchi slope (Sec. III.C.1.c). The MMS could require operators to conduct benthic surveys for such communities, in accordance with Stipulation 1, Protection of Biological Resources, thereby avoiding such communities. As explained in Section IV.C.1.c, we assume that during the abandonment phase the pipeline system would be abandoned in place, at which time it would become a public responsibility in perpetuity. Overall, the effect on lower trophic-level organisms with standard mitigation would be local but moderate.

IV.F.4. Fish Resources.

Some adverse effects to fish resources from a large spill would take decades to recover, but are likely reversible.

IV.F.5. Essential Fish Habitat.

Some adverse effects to EFH from a large spill would take decades to recover, but are likely reversible.

IV.F.6. Threatened and Endangered Species.

IV.F.6.a. Threatened and Endangered Marine Mammals.

Any irretrievable or irreversible commitment of resources important to the long-term survival and recovery of the bowhead whale probably would violate the ESA, unless such commitment was made to help protect and aid in its conservation and recovery. Some bowhead whales could be subjected to temporary nonlethal effects of disturbance due to noise from seismic activities, vessel and aircraft traffic, and drilling operations. In addition, there could be some loss and/or deterioration of habitat due to facility developments, although these would be minor. It is unlikely that such effects would lead to permanent (irreversible) losses of these resources for the bowhead whales. The bowhead population is increasing, so any mortality is likely to be relatively temporary and reversible.

The MMS concluded consultation with the National Marine Fisheries Service under Section 7 of the Endangered Species Act. In their Biological Opinion, the National Marine Fisheries Service concluded “...at this time, there is a reasonable likelihood that oil and gas development and production in the Alaskan...Chukchi Sea, as described, would not violate section 7(a)(2) of the Endangered Species Act,” and “...leasing and exploration are not likely to jeopardize the continued existence of the bowhead whale.”

IV.F.6.b. Threatened and Endangered Marine and Coastal Birds.

Some adverse effects to threatened and endangered birds from a large spill would prevent recovery to these imperiled populations. Foraging, nesting, staging, or molting habitats used by threatened and endangered birds, including designated critical habitat, could be irretrievably or irreversibly altered by activities associated with petroleum exploration and development. There are no suitable alternate habitats available. Such mortality and habitat losses would represent an irreversible effect to these populations.

IV.F.7. Marine and Coastal Birds.

Some adverse effects to marine and coastal birds from a large spill would prevent recovery to small, habitat-specific populations, and/or declining populations. Foraging, nesting, staging, or molting habitats used by marine and coastal birds for could be irretrievably or irreversibly altered by activities associated with petroleum exploration and development. In many cases, there are no suitable alternate habitats available. Such mortality and habitat losses would represent an irreversible effect to these populations.

IV.F.8. Other Marine Mammals.

Marine mammals 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.F.9. Terrestrial Mammals.

Terrestrial mammals 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.F.10. 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.F.11. Economy.

For the economy the commitment of human resources would be irreversible and irretrievable in the long and short term. That is, routine activity would generate employment at an enclave on the Chukchi shoreline or the Prudhoe Bay complex for workers who otherwise would reside permanently primarily in Southcentral Alaska. Also, it would generate a small increase in resident employment in OCS related activity in the North Slope Borough communities.

IV.F.12. 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.F.13. Sociocultural Systems.

No irreversible or irretrievable effects on social systems, cultural values, and institutional organization are expected from the proposed action.

IV.F.14. 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.F.15. 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.F.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.

Contents for Section V

SECTION V

CUMULATIVE EFFECTS

Contents for Section V

V. CUMULATIVE EFFECTS V-1

V.A. Introduction and General Conclusions V-1

- V.A.1. Guiding Principles of the Analysis V-1
- V.A.2. Structure of the Analysis V-1
- V.A.3. Scope of the Analysis V-2
- V.A.4. Significance V-2
- V.A.5. General Conclusions V-3

V.B. Activities We Considered in this Cumulative Effects Analysis V-4

- V.B.1. Past Development/Production V-6
- V.B.2. Present Development/Production (within the next few years) V-6
- V.B.3. Reasonably Foreseeable Development/Production (within the next 15-20 years) V-7
- V.B.4. Speculative Development (after 20 years) V-7
- V.B.5. Resource Estimates Used for this Cumulative Effects Analysis V-8
- V.B.6. State Lease Sales Considered in this Cumulative Effects Analysis V-8
- V.B.7. Federal Lease Sales Considered in this Cumulative Effects Analysis V-9
- V.B.8. Infrastructure and Transportation V-10
- V.B.9. Natural Gas Production and Transportation V-11

V.C. Analysis of Cumulative Effects V-11

- V.C.1. Water Quality V-14
- V.C.2. Air Quality 15
- V.C.3. Lower Trophic-Level Organisms V-17
- V.C.4. Fish Resources V-17
- V.C.5. Essential Fish Habitat V-18
- V.C.6. Threatened and Endangered Species V-18
 - V.C.6.a. Threatened and Endangered Marine Mammals V-18
 - V.C.6.b. Threatened and Endangered Marine and Coastal Birds V-30
- V.C.7. Marine and Coastal Birds V-30
- V.C.8. Other Marine Mammals V-31
- V.C.9. Terrestrial Mammals V-40
- V.C.10. Vegetation and Wetlands V-41
- V.C.11. Economy V-43
- V.C.12. Subsistence-Harvest Patterns V-45
- V.C.13. Sociocultural Systems V-68
- V.C.14. Archaeological Resources V-69
- V.C.15. Environmental Justice V-71

V. CUMULATIVE EFFECTS.

V.A. Introduction and General Conclusions.

V.A.1. Guiding Principles of the Analysis.

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 regulations implementing the National Environmental Policy Act (NEPA) (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 (CEQ), *Considering Cumulative Effects Under the National Environmental Policy Act, January 1997*, suggests 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).

V.A.2. Structure of the Analysis.

Based on 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 resulting from proposed Chukchi Sea Sale 193 on the natural resources and human environment that may occur in the Chukchi Sea and the adjacent offshore and onshore areas.
2. We analyze other past, present, and reasonably foreseeable future oil-development activity on the North Slope and adjacent offshore areas for effects on the natural resources and human environment that we found were potentially affected by proposed Chukchi Sea Sale 193.
3. We consider effects from other actions on these same natural resources and human environments.
4. We attempt to quantify effects by estimating the extent of the effects (for example, number of animals and habitat affected) and how long the effects would last (for example, population recovery time).
5. We weigh more heavily the activities that are more certain, closer in time, and closer geographically to the proposed lease sale to keep the cumulative-effects analysis concentrated on the effects that are in the proposed Sale 193 area.

Furthermore, we analyze more extensively those effects that are of greatest concern as identified during in scoping. We also focus our effort by using, where possible, guiding principles from existing standards (discussed below) 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. Scope of the Analysis.

Oil and gas activities considered in the cumulative analysis include: past development and production that is now existing infrastructure; present development where new facilities are under construction; and reasonably foreseeable development that is likely in the next 2 decades. Speculative activities that may occur at a later date or not at all are identified in the cumulative scenario. The discovery and development of fields more than 20 years from now is considered as speculative because the timing, size, and location of these future projects are unknown at the present time. Analyses of speculative activities and associated effects must therefore be treated in a very general way. We exclude future actions from the cumulative-effects analysis, if those actions are outside the geographic boundaries for the cumulative-effects analysis. To address the many uncertainties in our current knowledge, MMS policy is to implement monitoring of actual activities to determine the long-term cumulative effects that might result from oil and gas development in this region.

Activities other than those associated with oil and gas that may affect the environmental and sociocultural resources affected by the Proposed Action also are identified in the cumulative scenario and considered in the cumulative analysis. We also include by reference certain cumulative effects that are more national in scope, for example, climate change and alternative energy development.

V.A.4. Significance.

As directed by CEQ's NEPA 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 listed in the introductory paragraph. Our analysis considers the "context" and "intensity" of the impact as mentioned by the CEQ 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 (e.g., 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.5. General Conclusions.

Conclusions about effects on specific resources follow later in this section. If the oil resources we assumed would be developed are indeed developed and produced, then our general conclusions of this cumulative analysis are:

- Potential cumulative effects on the bowhead whale, subsistence, sociocultural systems, spectacled eider, polar bear, and caribou would be of primary concern and warrant continued close attention and effective mitigation practices.
- The Chukchi Sea is a frontier area; therefore, any impacts from Sale 193 would be the primary contributor to any OCS Program impacts.
- Significant impacts are anticipated to occur to threatened and endangered birds because mortalities could not be recovered if these populations continued to decline. We estimate that no significant cumulative impacts would result from any of the routine activities associated with Alternative I for Sale 193. In the event of a large offshore oil spill, some significant adverse impacts could occur to biological resources, sociocultural systems, and Environmental Justice. Most resources that would be contacted by an oil spill are expected to recover within two to three generations. These same resources are not expected to be contacted by a subsequent oil spill prior to their recovery. 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 a resource, or the resource might be considered tainted and unusable as a food source. The potential for adverse effects to some key resources is of primary concern and warrants continued close attention. Effective mitigation practices should be considered in future projects.
- Potential Environmental Justice effects would focus on the Inupiat communities of Barrow, Wainwright, Point Hope, Point Lay, and Kivalina, within the North Slope Borough. In the 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.6. 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 cause-and-effect relationships on the intangible quality of life. Similarly, as we move from the terrestrial environment to the offshore environment, the variables defining environmental quality also increase. Migratory species present additional variables that reflect habitat and species condition outside the primary area of analysis in northern Alaska. 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 complicated and less conclusive.

We assessed cumulative effects in this EIS to determine whether these effects are additive or synergistic or have 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 ($1 + 1 = 2$). 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), few studies have been undertaken to look at such impacts occurring when dealing with biological resources in the arctic environment. We recognize that potential synergistic impacts could occur, but up to now we found none in our past lease sale analyses or in our assessment of cumulative effects. In sections, where synergistic impacts were not specifically enumerated, it was because there were neither studies nor information to lead us to specifically identify such impacts.

Potential cumulative effects are likely to be mitigated somewhat by the following factors:

- Future oil and gas activities are more likely to have lower direct impacts on the environment than past activities conducted decades ago in the early years of the region's development. More rigorous standards and more environmentally prudent industry practices are now routinely used. Examples include: smaller facility "footprints," roadless facilities, directional drilling, elimination of surface discharges, improved vehicle designs that avoid damage to the tundra, and better working relations with the local residents.
- There is a growing volume of scientific studies and monitoring to design effective mitigation measures. Current industry practices and the environmental conditions on the North Slope and adjacent offshore areas are frequently monitored and assessed, and much of this information is available to the public. This information contributes to the ongoing dialogue about environmental issues among Federal, State, and local government agencies; Inupiat regional and village corporations; the oil/gas industry; special interest groups; and the public. This dialog effectively increases environmental awareness and encourages sound practices that, in turn, should reduce the potential for environmental damage. One example is the MMS established a Beaufort Sea monitoring program focused on the Northstar Project and the Liberty Project area. Data have been collected since 1999 to establish a baseline for the Liberty and to monitor Northstar during construction, development, and production. This program will provide information to decision-makers who could modify monitoring or mitigation procedures at a later date.
- The TAPS is expected to continue to serve as the main transportation system for oil production from northern Alaska in the foreseeable future. Other North Slope facilities (processing plants, roads, support services) are also in place to serve future production from the Chukchi Sea. This means that

additional development will not necessarily require extensive new infrastructure with associated environmental impacts.

- If a major oil spill occurred, there likely would be a slowdown in new development during which additional safeguards certainly would be implemented. Just as the additional safeguards resulted from the EVOS, the likelihood of an additional oil spill from the same causative factors and to the same resources would be much lower.

V.B. Activities We Considered in this Cumulative-Effects Analysis.

The actual size and location of future oil and gas developments on the North Slope and in the Chukchi 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. In Section V.B, we describe the activities and projects considered in the cumulative impact analysis. These activities include past development and production, present development, reasonably foreseeable future development, and speculative development. In Section V.C, we present the assumptions used by each resource specialist in the remainder of the analysis in that section.

To provide consistency in our analysis, we formulate scenarios for future activities. These scenarios represent feasible activities but are really only hypothetical views of the future. However, the cumulative-effects assessment and the other alternatives associated with Sale 193 are based on the scenarios which provide a common framework for the timing and extent of future petroleum activities in the Chukchi Sea. The scenarios do not necessarily represent the only possible view of future activities nor do they suggest the activities favored by government. Scenarios are merely conceptual views of the future to provide a common framework for subsequent analyses. Readers should be aware that uncertainties in the analyses themselves are preceded by uncertainties in the scenarios.

Our scenarios include estimates for both exploration and development/production activities. Exploration activities are considered to be more predictable because they occur closer to the present time and are a natural extension of the leasing process. That is, it is reasonable that companies who purchase leases will attempt to test these leases for commercial oil and gas accumulations. This will occur in a foreseeable timeframe, as leases are only valid for 10 years from the lease sale. However, only a small fraction of leases are ever tested by drilling (less than (<) 5% in Alaska). After 30 years of leasing in the Alaska OCS, there are no commercial oil or gas facilities located on Federal OCS lands. Industry refers to Alaska as a “frontier province,” because it is in a very early stage of exploration and development, compared to “mature provinces” such as the Gulf of Mexico. Development in this frontier area would be a departure from a long history of only exploration activities in this offshore frontier area.

In the 20th century, oil and gas activities have been the main agent of industrial-related change on the North Slope. Prior to this, commercial whaling was the primary industrial agent affecting biological and socioeconomic changes throughout northern Alaska. Extensive oil and gas exploration activities have occurred on the Alaska North Slope since the 1940's and large-scale development began in the 1970's with the Prudhoe Bay field. Exploration activities moved offshore into Beaufort Sea and Chukchi Sea in the 1970's and development/production in the nearshore Beaufort Sea began in the early 1980's. The center of industrial development (or so-called “core area”) was around the Prudhoe Bay field and included the creation of an industry support community and airfield at Deadhorse with an interconnected industrial infrastructure that includes roadways, pipelines, production and processing facilities, gravel mines, and docks. In 1977, the TAPS was completed to transport North Slope crude oil to a year-round marine terminal in Valdez, Alaska and it continues operation today. In November 2002, the TAPS Right-of-Way was renewed for another 30 years by both State and Federal agencies.

Despite a history of encouraging exploration, but no actual development of offshore oil resources, for purposes of environmental analysis we assume that development will take place as a result of leasing in Sale 193. This development is assigned an estimated volume of future oil production. Estimates of anticipated production consider many factors, including the economically recoverable resources assessed in the area, past industry leasing and exploration efforts, and future economic conditions (oil price).

Under optimum conditions, a typical chance a commercial field will be discovered in a frontier area is <20%. Considering the difficult operating conditions and high costs, the commercial success rate on the North Slope has been much lower (<5%). One could expect that higher prices and attractive geology could result in a success rate in the Chukchi Sea <10% (or 1-in-10 chance) because of more challenging conditions than adjacent onshore areas. Given these realities, the estimates assumed for anticipated production are likely to be overstated. Similarly, the associated environmental effects of development are also likely to be overstated in the analyses.

Of all of the factors analyzed, the timing for future production is the most uncertain. For example, the Liberty prospect in the Beaufort Sea was first leased in 1979 and discovered in 1982 (at that time it was called the Tern Island prospect). Exploration drilling in 1997 reconfirmed it as a commercial-size pool (renamed the Liberty Project by BPXA). Various project proposals, studies, and permitting steps have taken place until the present time, and development work has not started. This prospect lies only 7 miles (mi) offshore in 20 feet (ft) of water and <30 mi from the TAPS. For comparison, the primary area of interest in the Chukchi Sea is more than (>) 50 mi offshore in >100 ft of water and nearly 300 mi from the TAPS. This implies that cost, engineering, and regulatory hurdles will be much more difficult in the Chukchi Sea with greater uncertainty of when (or if) oil development would occur.

We focus our analysis on the following:

- Oil and gas discoveries that have a reasonable chance of being developed during the next 20 years.
- Exploration of undiscovered resources onshore and offshore that could occur during the next 20 years.
- Speculative exploration and development activities that could occur in onshore and offshore areas beyond 20 years from the present time.
- Continued operation of the TAPS and tanker shipments of oil to markets in the Pacific Basin.
- Activities other than oil and gas, including sport and subsistence hunting and fishing, scientific surveys, and marine transportation. We do not attempt to estimate future military activities affecting this region.

Table V-1 lists the existing North Slope fields and discoveries that could be developed in the future. According to our definitions, a “field” refers to infrastructure in a participating area that could be used to produce several pools; a “satellite” is a pool developed through larger, nearby facilities; a “pool” is a defined accumulation with proven reserves; a “prospect” is a discovery with producible oil or gas tested by one or more wells; a “show” is discovery that may not be producible (technically or economically). These general categories provide a framework for our subsequent analysis.

For purposes of this cumulative analysis, we divide oil and gas accumulation into the following categories:

- **Past Development/Production:** Thirty-one fields and satellites have been developed on the North Slope. This infrastructure area is approximately 200 mi from the nearest coastline of the Chukchi Sea. Two projects are located offshore in the Beaufort Sea (Endicott and Northstar), and they also have satellite pools (Sag Delta, Sag Delta North, Eider). Two more offshore oil fields have been developed from onshore locations (Point McIntyre and Niakuk). For purposes of analysis, we define onshore/offshore depending on where the facility is located. The Point McIntyre and Niakuk pools are located mostly offshore but the production facility (wells and pipeline) are onshore, so they are listed as “onshore” fields.
- **Present Development/Production:** Three discoveries are under construction and expected to start up production as satellite fields within the next few years. Two of them are onshore (Fiord and Nanuq tied to Alpine), and one is offshore (Oooguruk tied to Kuparuk).
- **Reasonably Foreseeable Future Development:** Twenty-three discoveries are listed that might have development-related activities (site surveys, permitting, appraisal drilling, or construction) within the next 20 years, including several offshore fields in the Beaufort Sea (Liberty, Sandpiper, Kuvlum, Thetis Island, Stinson, and Hammerhead). There are no discoveries listed in the Chukchi Sea. It is likely that gas development and production could occur in the core area around Prudhoe Bay if a gas pipeline is constructed from the North Slope. Gas development/production from offshore fields is not expected within the next 20 years.
- **Speculative Development:** Thirteen discoveries are listed under the speculative category because they are likely to be too small and costly to develop within the next 20 years. Given the high

petroleum resource potential of northern Alaska, other discoveries are likely to be made as a result of exploration beyond the 20 year timeframe for the “foreseeable” future. It is reasonable to anticipate higher levels of activities onshore compared to offshore because of lower costs, easier logistics, and proximity to existing infrastructure. Undiscovered resources generally are described as speculative, because these pools have not been identified in size or location. Full-scale gas development from the offshore also is considered speculative, because the key transportation system (probably a large-diameter pipeline) may never be constructed.

We focus our analyses on past, present, and reasonably foreseeable activities (the first three categories) and treat activities associated with the speculative category in a more general way. We recognize that companies may produce oil from pools now listed as speculative but the size, location, and startup date for these fields is unknown today. Some of the discoveries listed were made as far back as 1946 but have not been developed for economic and technical reasons. It is possible also that companies will delay development of some prospects listed in the reasonably foreseeable category because of economic, technical, or regulatory hurdles.

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

V.B.1. Past Development/Production.

While there has been no development or production in the Chukchi Sea, it is relevant to describe the infrastructure on the North Slope because future production from the Chukchi Sea is likely to use these facilities.

Table V-1 lists the producing fields on the North Slope and nearshore areas of the Beaufort Sea. Infrastructure, past 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 3 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-1). Table V-2 lists production and reserve data through year-end 2005. Additional discussion of the history of North Slope development and listing of infrastructure components is given in USDO, BLM (2005b:Sec. 4.7.1.1 and Table 4-33). 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 (MMbbl) of oil. The Niakuk, Point McIntyre, and Badami oil pools are located mainly offshore but are produced from onshore facilities. 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 is an offshore field that is covered by both State and Federal OCS leases. It began producing on October 31, 2001.

V.B.2. Present Development/Production (within the next few years).

This category includes fields that are in stages of development (permitting or construction) and production is expected within a few years. Infrastructure components, scheduling, and reserve estimates are fairly well defined, although reserve volumes could be revised. These new developments will be tied into existing infrastructure as satellites, and they depend on the nearby infrastructure to be viable.

This category contains three discoveries: CD-3 (Fiord) and CD-4 (Nanuk) are onshore satellites tied to the Alpine infrastructure. Oooguruk is an offshore field tied as a satellite to the Kuparuk infrastructure. The onshore fields are on State leases and will be developed on gravel pads. The offshore field will be developed from at least one artificial gravel island. Current reserve estimates total about 160 MMbbl for these three fields (Table V-3), although the estimates are somewhat uncertain at the predevelopment stage.

V.B.3. Reasonably Foreseeable Future Development/Production (within the next 15-20 years).

For purposes of analysis, we estimated that one oil field containing 1 billion barrels (Bbbl) would be developed as a result of Sale 193. The location of this field is unidentified at the present time; however, we include it in the reasonably foreseeable analysis because it could result from leasing. We do not include undiscovered resources from adjacent areas (Beaufort and North Slope) in this category, because they are speculative as to timing of discovery, location of development, and ultimate volume of production. A listing of future lease sales in Alaska and Federal lands is given in Table V-4, and for purposes of analysis we assume only exploration activities will occur in the foreseeable future as a result of these leasing programs.

The MMS has defined reasonably foreseeable future development with respect to historical trends and timeframe. This category includes ongoing activities that are reasonably expected with the next 20 years. Most likely, these activities would begin with development of discoveries close to existing field infrastructure. We have ranked the chance and time of development according to resource size and proximity to existing infrastructure, given that resource volumes are still fairly uncertain in this category. Because there is inadequate data in the public domain, we do not attempt to define recoverable reserves on a field-specific basis nor describe the designs of future facilities. As it is a company decision, we cannot accurately define the timing for development either. Many of these discoveries were made decades ago and remain undeveloped today. Without advancements in technology and sustained high oil prices, many of these discoveries could remain undeveloped in the future.

While the list of reasonably foreseeable future developments includes new field discoveries, there also could be significant amounts of oil recovered from existing fields and from satellite pools close to infrastructure areas. Enhanced recovery adds additional production from known reservoirs, creating "reserve growth." For example, the Prudhoe Bay field was originally estimated to hold 9.6 Bbbl of reserves, and now it has reserves approaching 13 Bbbl. More than 3 Bbbl were added by using enhanced recovery technologies. In addition, industry has indicated that they have identified a number of prospects close to existing infrastructure that may become future satellite pools. Although the volume of these new resources (reserve growth and satellites) is somewhat uncertain, it is reasonable to assume that they will be brought into production in the next 20 years because they are closely associated with existing infrastructure (roads, pads, production facilities, pipelines). The environmental consequences of new satellite development and reserve growth would be minor.

This category includes 23 potentially commercial discoveries that could be developed in the next 20 years (see numbers 36 through 57 in Table V-1). We define "onshore" and "offshore" fields according to where the production facility is located. Some of the pools located offshore are developed from onshore sites and therefore are listed as onshore fields. Offshore fields in this category are Liberty, Sandpiper, Flaxman Island, Kuvlum, Hammerhead, Thetis Island, Nikaitchiuq, Tuvaq, and Stinson. Sandpiper, Liberty, Hammerhead, and Kuvlum are on offshore Federal leases; all others are on State leases or NSB lands.

The discussion of reasonably foreseeable future exploration/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. It is important to recognize the distinction between exploration/development activities and production. The discussion of exploration/development activities is related primarily to short-term (a few years) disturbance effects, whereas the production activities involve longer-term disturbance (decades) and the potential for oil-spills. We have attempted to rank the chance for commercial development of these discoveries from highest to lowest (Table V-1). 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 sub-commercial discoveries and undiscovered resources that are unlikely to be developed beyond 20 years in the future. Some of the discoveries listed in Table V-1 were made 50 years ago and remain undeveloped today. There are a variety of reasons, including very remote locations, low production rates, and lack of gas-transportation systems that will inhibit activities associated with these resources in the

foreseeable future. With respect to undiscovered resources, it is difficult to accurately predict the timing of development, new infrastructure requirements, or the environmental effects associated with development projects that have not been located. These are speculative resources that may or may not ever be developed. This category also includes undiscovered oil resources expected to be leased and eventually developed as a result of future State and Federal lease sales in northern Alaska. Development of these resources would be beyond a 20-year timeframe from the present.

To represent the scale of future exploration and development activities in the speculative category, we summarize the resource assessments by various government agencies. The geologic potential recoverable by current or foreseeable technology, without regard to economics, is listed in Table V-5. It is reasonable to assume that the level of future activities will be proportional to the geologic potential in these areas if they are open to leasing and exploration. High-potential areas could be expected to have higher levels of exploration and development.

Development and production of gas resources on the North Slope and from the Arctic OCS is included in the speculative category. Large volumes of natural gas have been identified as associated with oil fields on the North Slope. These proven resources are uneconomic to produce, because there is no gas-transportation system to market. The largest gas accumulation on the North Slope is in the Prudhoe Bay field (approximately 23 Tcf available now for sale; see Table V-2 for other stranded gas resources). Various plans have been studied to bring North Slope gas to market (see Table V-6), but no plan has overcome the high project cost and marketing hurdles. At present, the most likely transportation system is a large-diameter gas pipeline to markets outside of Alaska. Such a pipeline is considered by MMS to be speculative at this time for reasons presented in Section IV.A.2. Upwards of 35 Tcf are readily available in known accumulations on the North Slope, and these proven resources are likely to take all available capacity in the new gas pipeline for the first 10-15 years of its operation. It is very unlikely that development of remote, undiscovered, and higher cost gas resources would take priority over the development, production, and transport of more supplies of known available gas reserves. Therefore, for purposes of cumulative analysis, we do not assume any gas production from the offshore area or the National Petroleum Reserve-Alaska (NPR-A) is reasonably foreseeable at this time.

Because the existing North Slope oil infrastructure has the capability to handle large amounts of natural gas, it is not anticipated that a large increase in infrastructure, other than installation of the new gas pipeline itself, would be necessary to support a gas pipeline. Approximately 8 billion cubic feet (Bcf) per day is handled by North Slope facilities, and the new gas pipeline is likely to carry 4.5-6.0 Bcf per day.

V.B.5. Resource Estimates Used for this Cumulative-Effects Analysis.

Tables V-7a through V-7c provide the reserve and resource estimates we use for analyzing cumulative effects. We estimate a low range of 6.6 Bbbl, a mid-range of 10.1 Bbbl, and a high range of 17.8 Bbbl of oil reserves and resources that may be produced on the onshore North Slope and in the Beaufort and Chukchi Seas.

V.B.5.a. The Low Range-Past and Present Production.

The low end of the range for this cumulative analysis is 6.6 Bbbl (rounded), which includes past and present production. This includes reserves (6.4 Bbbl) in currently producing fields (Table V-2) and undeveloped reserves (0.16 Bbbl) in prospects currently in the planning or development stages (Table V-3). Future oil production from Sale 193 (1.0 Bbbl assumed) represents approximately 15% of the current reserve volume in existing fields and projects under development on the North Slope.

V.B.5.b. The Midrange - Past, Present, and Reasonably Foreseeable Future Production.

The midrange for the cumulative analysis is 10.1 Bbbl (rounded), which includes past, present, and reasonably foreseeable future production. This includes the 6.6 Bbbl from the current production activities (discussed above) plus new development that may begin in the next 20 years. As discussed above, we largely restrict the volumes assigned to the reasonably foreseeable category to pools that have been discovered and are likely to be commercially viable at current high oil prices. Reasonably foreseeable production (3.5 Bbbl) consists of 2.0 Bbbl in onshore pools and 1.5 Bbbl in offshore pools (Table V-1), 1.0 Bbbl of which is assumed to be discovered in the Chukchi Sea as a result of Sale 193. This Chukchi discovery represents about 10% of the total volume of the past, present, and reasonably foreseeable future production (Table V-7b). In addition to oil

production, we assume that natural gas would be produced for sale to outside markets. Natural gas has been cycled in North Slope oil fields for decades and would be readily available (produced through existing infrastructure) when a new North Slope gas-transportation project is completed (see Table V-6). For purposes of analysis, we assume that this will occur within the next 20 years.

V.B.5.c. The High Range - Past, Present, Reasonably Foreseeable Future, and Speculative Production.

The high range for the cumulative analysis is 17.8 Bbbl (rounded), which includes existing, planned, possible, and speculative production. This includes 10.1 Bbbl from the midrange (discussed above) plus speculative oil production (7.7 Bbbl) from undiscovered resources that may be developed 20 years or more in the future. These estimates include an estimated 2 Bbbl in undiscovered resources in the offshore (Beaufort and Chukchi) plus 5.7 Bbbl in undiscovered onshore resources on State and Federal (NPR-A) lands (see Table V-1). The Sale 193 EIS scenario assumes the development of 1 Bbbl, which represents about 5.6% of the total of past, present, reasonably foreseeable future, and speculative production (Table V-7c).

V.B.6. State Lease Sales Considered in this Cumulative-Effects Analysis.

Since December 1959, the State has held approximately 32 oil and gas lease sales involving North Slope and Beaufort Sea leases. More than 4.6 million acres have been leased, and some of the tracts have been leased more than once because the leases expired or were relinquished. Historically, only about half of the tracts offered in State oil and gas lease sales have been leased. Of the leased tracts, about 10% were drilled and only about 5% have been commercially developed. About 78% of the State leased acreage was onshore and about 22% was 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 (see Table V-4). Except Northstar, all of the North Slope and Beaufort Sea's commercially producible crude oil is on State leases. The production to date from State leases totals nearly 15 Bbbl (Table V-2), and approximately 52 Tcf of natural gas has been cycled through facilities. All of this gas production has either been used as fuel for facilities or reinjected to increase oil production.

The State of Alaska has not estimated oil and gas resources for its future lease sales, although the U.S. Geological Survey (USGS, 2005) recently completed a resource assessment of State lands on the North Slope. The USGS estimates that 4.0 Bbbl of oil and 33.3 Tcf of natural gas occur in undiscovered pools (Table V-5). Using industry estimates, we assume that approximately 2.0 Bbbl of oil will be developed in the foreseeable future as satellites, heavy oil, and reserve growth in existing pools (these resources are not included in the 2005 USGS assessment). We include 2.0 Bbbl of undiscovered oil resources as speculative resources developed on State lands beyond the timeframe for this analysis (several decades in the future). All undiscovered gas resources are considered to represent speculative future development because natural gas is stranded on the North Slope.

V.B.7. Federal Lease Sales Considered in This Cumulative-Effects Analysis.

We consider Federal OCS activities in the Beaufort and Chukchi Sea program areas as well as leasing in the NPR-A in this analysis. Although no significant production has occurred from the Federal OCS off Alaska (Northstar has a small amount of Federal oil production), these areas hold considerable potential for undiscovered resources (see Table V-5). It is reasonable to assume that exploration activities will continue in these Federal areas in northern Alaska. However, commercial development faces difficult technical, economic, and political challenges.

As a brief history of activities in the Chukchi Sea, the area was once divided into two planning areas, the northern portion as part of the Beaufort Sea Planning Area and the remaining part being in the current Chukchi Sea Planning Area. Portions of the current area were offered in four previous lease sales (Sales 97 and 109 in 1988 and Sales 124 and 126 in 1991). A total of 483 tracts were leased in these four sales (approximately 2.7

million acres) and attracted \$512 million in total high bids. Exploration associated with these lease sales included approximately 100,000 line-miles of 2D seismic data, with nearly three-quarters of the total line miles acquired between 1980 and 1989. As shown on Map 1, five large prospects were drilled (Burger, Klondike, Crackerjack, Popcorn, and Diamond) between 1989 and 1991. Although most of the five Chukchi shelf wells encountered favorable geology, none discovered commercial quantities of oil or gas, and exploration of Chukchi shelf was discontinued. Through successive rounds of relinquishments, industry lease holdings gradually diminished and, of the 483 leases active on Chukchi shelf in 1992, none remain active today.

At the present time, there are 173 active leases on Federal submerged lands in the Beaufort Sea, including portions of several discoveries that are potentially producible (Fig. III.A-1). However, there are no publicly available estimates of proven resources in these prospects. The Northstar Unit includes three Federal tracts that contain 15-20 % of Northstar's estimated 158 MMbbl of oil reserves. Approximately 20% of the total undiscovered conventionally recoverable oil resources in the Beaufort Sea is estimated to occur under existing OCS leases. The remaining undiscovered resources (80%) represent is an attractive target for future exploration. However, as in other remote areas in northern Alaska, commercial development faces difficult technical, economic, and political challenges and will require sustained oil prices above \$25 per barrel.

The U.S. Department of the Interior (USDOI), Bureau of Land Management (BLM) has held 7 lease sales in NPR-A since 1982, the most recent of which was in September 2006. An overview of past leasing and exploration activities in NPR-A is given in USDOI, BLM (2005:Sec. 4.7.2.1). Four sales since 1999 leased a total of 397 tracts (3,790,211 acres) of which 381 leases are still active. A total of 20 exploration wells were drilled since 1999, with announced discoveries of gas, oil, and condensate in of the five wells in the NE NPR-A plan area. The BLM plans to continue lease sales in the NPR-A, and work is underway for leasing in the southwestern part of the area (South Plan) around 2010.

V.B.8. Infrastructure and Transportation.

Full-scale oil production began on the North Slope in 1977 with completion of the TAPS and peaked 1988. Since then, new development has not entirely replaced declining oil production from older fields. At its peak, the TAPS carried nearly 2.1 MMbbl per day from the North Slope to the port of Valdez in southern Alaska and now transports approximately 900,000 bbl per day (State of Alaska, Dept. of Natural Resources [ADNR], 2006a). Although TAPS has capacity for more oil, most of the production facilities on the North are operating at maximum capacity for water and gas handling (Kaltenbach et al., 2004). There is no transportation system for natural gas to be transported from the North Slope to market, and all gas associated with oil production is used as fuel for facilities or reinjected to increase oil recovery.

The scenario for new petroleum development in the Chukchi Sea was postulated in view of the existing infrastructure on the North Slope because it is likely that future projects in northern Alaska will be tied into these facilities. The TAPS is assumed to carry oil production from the Chukchi which could begin in 2020 (Table V-6). Peak oil production rate from the first offshore field is assumed to be approximately 225,000 bbl per day and would constitute a 25% increase to the current rate through TAPS. This increase would require upgrading the pipeline and pump stations from their current condition because many of the pump stations have been idled. There is no infrastructure in NPR-A at the present time, so a new large-diameter gathering line would have to be constructed from the Chukchi coast to the Prudhoe Bay area. If such a pipeline, or portions of such a pipeline, were to be proposed, it would need to meet all regulatory and permitting requirement, including compliance with Section 810 of the Alaska National Interest Lands Conservation Act of 1980. Permitting for such a pipeline would require all appropriate technical, engineering, and environmental reviews. The overland oil pipeline(s) would be elevated aboveground and pump stations would be needed at about 100-mi intervals. The size and location of the overland pipeline(s) will be influenced by future discoveries and development in the NPR-A, but it is logical to assume that they would be oriented west-east in the shortest corridor to Pump Station No. 1. Separation of associated-dissolved gas and produced water from the offshore field would be done on a central production platform to avoid bottlenecks in facilities near Prudhoe Bay. Natural gas would not be transported across NPR-A until a transportation system is constructed from the North Slope to Outside markets (see Sec. V.B.9 below).

V.B.9. Natural Gas Production and Transportation.

Large amounts of natural gas have been discovered during exploration on the North Slope, much of which is associated with oil. Since the mid-1970's numerous conceptual strategies have been offered to move natural gas from the North Slope to market. However, proven gas resources of approximately 35 Tcf and undiscovered gas resources of approximately 200 Tcf remain stranded because no transportation system has been constructed.

The main gas transportation strategies are outlined below. Without favoring a specific proposal by name, these projects generally fall into three categories. It is uncertain which project (or combination of projects) will eventually be constructed.

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

Through the years, each strategy has appeared to be more feasible at different times. At present, an overland pipeline system through Canada is the most popular, but it should be recognized that a very similar proposal project (called the Alaska Natural Gas Transportation System or ANGTS) appeared eminent in the late 1970's. A discussion of the relative merits of these gas transportation strategies is given in Sherwood and Craig (2001).

With regards to the development scenario for the Chukchi OCS, it is clear that any large-scale gas-transportation system from the North Slope will not be operational for at least a decade, and excess capacity in this system will not be available for another decade after that. When there is capacity in the system, new gas developments are likely to be prioritized according to accessibility and cost. This means that remote, high-cost projects in the Chukchi will be less attractive than closer, lower cost projects. Also, considerable gas resources will have to be discovered in the Chukchi to justify a large overland pipeline to the Prudhoe Bay area. All of these factors suggest that gas development in the Chukchi OCS should not be included in the reasonably foreseeable scenario. Therefore, offshore gas development and transportation impacts are not thoroughly analyzed in this EIS.

V.C. Analysis of Cumulative Effects.

Assumptions Used in the Analysis: This EIS evaluates the potential effect of holding the proposed Lease Sale 193 in the Chukchi Sea. The decision will be whether to hold Sale 193 as proposed (Alternative I), or modify the area offered (Alternatives III and IV), or to not hold the sale at all (the No Action Alternative). The cumulative analysis that follows evaluates the contribution of holding the Lease Sale 193 to the cumulative effects.

The Chukchi Sea Planning Area encompasses approximately 6,156 whole or partial blocks (about 34 million acres) and was identified as the program area in the 2002-2007 5-Year Program. The proposed Sale 193 area excludes a 15- to 50-mile-wide corridor along the coast, the polynya or Spring Lead System. Water depths in the sale area vary from 95 ft to approximately 262 ft. A small portion of the northeast corner of the area deepens to approximately 9,800 ft. For analyses, the scenario assumed the discovery, development, and production of the first offshore oil field in the Chukchi Sea. 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. Lease Sale 193 is expected to result in one development project that could occur in any portion of the Chukchi Sea Planning Area.

The scenario from the cumulative effects analysis for Lease Sale 193 differs from the scenario for cumulative effects in the 2002-2007 5-Year Program in part because the 5-Year Program considered an expanded geographic area. At the individual lease sale stage of analysis, the cumulative impacts analyses is focused on activity resulting from the individual lease sale and the contribution this activity would make to overall impacts already occurring as a result of existing oil and gas activities. The geographic area is 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. For analysis purposes, future activities associated with the existing Beaufort Sea development projects and future Beaufort Sea exploration activities are considered to be reasonably foreseeable while new development projects are considered speculative.

The cumulative-effects analysis 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 (Sec. IV.C), we used the existing environment (Sec. 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 Lease Sale 193 to the existing baseline at the present time. This baseline changes over time with additional uses; also requires an accounting of the ongoing environmental change over time.

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 large 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/Chukchi Sea (Table V-7b). The incremental contribution of Alternative I for Sale 193 by volume of oil is a small portion (about 10%) of the midrange production estimate. To determine the number of large 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 1,000 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 193 also is zero (Table V-8). The mean number of estimated offshore spills for the Chukchi Sea offshore area statistically is 0.51.

The most likely number of onshore large oil spills greater than or equal to 500 barrels (bbl) from all past, present, and future activities is estimated to be five, the most likely number of spills from Alternative I for Sale 193 is estimated to be 0 (Table V-8). The mean number of estimated onshore spills for the North Slope area statistically is 5.40, of which Alternative I for Sale 193 is estimated to contribute statistically only 0.11 or 0.02%.

The most likely number of TAPS pipeline large oil spills greater than or equal to 500 barrels is estimated to be 2; the most likely number of spills from Alternative I for Sale 193 is estimated to be 0 (Table V-8). The mean number of estimated pipeline oil spills statistically is 2.12, of which Alternative I for Sale 193 is estimated to contribute statistically only 0.21 or 10% (Table V-8).

Monitoring studies are available for some biological populations that have experienced past and are experiencing present industry activities in the Beaufort Sea area while no development activity exists at present in the Chukchi Sea Planning Area at this time. However, where appropriate, this information has been factored into the abundance and distributional status and trends of the populations in lieu of not having any information at all for the Chukchi Sea. 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 caribou herds, have increased over the past 30 years while others, such as the spectacled eiders and polar bears have decreased. However, the exact causes of these population changes are difficult to determine.

The analysis of each resource has been weighed with respect to past, present, and future activities, as appropriate, to best predict the effects of Lease Sale 193 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 Chukchi Sea (particularly Ledyard Bay) 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 past and present activities onshore at Prudhoe Bay, the Kuparuk River, Milne Point, Alpine, Barrow gas fields, and offshore at Badami, Endicott unit, Northstar unit, and Oooguruk. 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.

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 Lease Sale 193. 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 193.

In summary, Alternatives III and IV, 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 IV are even smaller. The measurable effects of Alternative I for Sale 193 do not necessarily translate to measurable effects in the cumulative analysis because of the larger scale and timeframe required for the cumulative analysis.

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. 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. In the following sections we analyze the potential cumulative effects to individual resources.

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 and significant impacts are discussed in Section IV.A.1. In the event of a large offshore oil spill, some significant adverse impacts could occur to spectacled eiders, long-tailed ducks, common eiders, polar bears, 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 less likely that an oil spill would contact these resources. Spectacled eiders, long-tailed ducks, and common eiders are present on the North Slope for as long as 8 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, 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.

For the cumulative analysis, a scenario that assumes any offshore oil development in the Chukchi OCS represents an abrupt increase in the level of activity compared to the past. There have been no lease sales and virtually no petroleum exploration in the Chukchi Sea since 1991. The current petroleum assessment indicates that the mean recoverable oil resource is 12 billion barrels (Bbbl) with a 5% chance of 29 Bbbl. It is reasonable to assume that exploration of this area could lead to significant oil discoveries. The uncertainty is whether offshore development will follow successful exploration. In a frontier area, this is not a solid assumption. However, for purposes of analysis we assume that one large oil field will be developed as a result of the Chukchi Sea lease sale. Also, the proposed level of infrastructure and facilities proposed for Alternative I for Sale 193 (Table IV-A.1.) and a possible schedule for the scenario is given in Table IV.A-2a.

V.C.1. Water Quality.

Cumulative effects on water quality include effects from the assessment scenario (Sec. IV.A) and other past, present, and reasonably foreseeable projects (see Table V-7c). The present water quality of the Alaska Arctic OCS area is generally pristine; detectable pollutants occur at very low levels in the arctic waters and/or sediments and do not pose an ecological risk to marine organisms. Industrial impacts are minimal; degradation of the water quality presently is confined almost exclusively to external intrusions and naturally occurring processes. Future anthropologic impacts to water quality in the Chukchi Sea primarily would be caused by discharge of pollution into the marine waters from source and nonsource discharges.

Cumulative effects could lead to changes in the assessed impacts associated with the Proposed Action (Sec. IV.C.1); however, water quality standards and other applicable Federal and State regulatory policies that are relevant to the analysis in Section IV.C.1.a, would remain relevant and applicable for cumulative effects. Although the cumulative level of effects may increase the level of projected assessed impacts, the hypothetical activities described in the scenarios are not expected to contribute to significant impact or degradation of the Chukchi Sea's water quality.

Activities that occur within the Chukchi OCS, including the State offshore coastal zone area, will require review from the MMS, the public, and other applicable Federal and State environmental regulatory agencies prior to those activities proceeding. Activities will not be approved until it is certain they do not cause significant impacts to Chukchi Sea water quality, human health and safety, or the environment in general.

Summary. Activities from Sale 193 may cause small, localized increases in the concentrations of pollutants to water quality (Sec. IV.C.2.a, Water Quality). Effects on local water quality are expected to be low, while regional effects are expected to be very low. These effects are considered to be temporary in nature, precipitating over a small period of time after the discharges cease. A large oil spill would be an accidental event with possible significant impacts. Federal regulations require and implement strict oil-spill-prevention standards.

Sustained degradation of water quality to levels above State and Federal criteria from contamination resulting from the lease sale is unlikely. Compliant postlease activities do not pose a significant degree of risk to water quality. While the Proposed Action may have an impact upon the water quality of the Chukchi Sea, effects are expected to be low both locally and regionally. The resources in this area still could be affected by other significant discharges that may occur elsewhere in the sale area.

Reducing the impact resulting from oil-exploration activities to water quality can be addressed effectively through mitigation (design and procedural), coordination, and future permitting processes, including Federal, State, and local processes as applicable.

Contribution of Alternative I to Cumulative Impacts. Effects on local water quality resulting from postlease activities are expected to be low, while regional effects are expected to be very low. The projected exploration and development from the Proposed Action would represent only a small percentage of the foreseeable

cumulative activities; activities resulting from the sale are not projected to contribute significantly to cumulative effects on water quality.

V.C.2. 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.

In the Alaska Arctic, Prudhoe Bay and Kuparuk River fields are the principle oil- and gas-producing fields. Air monitoring at a number of sites in the Kuparuk and Prudhoe Bay fields showed that concentrations of nitrogen dioxide, sulfur dioxide, and PM₁₀ (particulate matter less than 10 microns in diameter) 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 (m) from the facility boundary and would be considerably lower at 1 kilometer (km) from the facility. We consider that their results are representative of what we could expect from any development resulting from Alternative I. 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 (USDOJ, 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 2007-2012 (USDOJ, MMS, Herndon, 2007) 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 event of a large oil spill, the concentrations of volatile organic carbons (VOC's) would increase rapidly near the spill site, but concentrations would dissipate rapidly and would be much reduced after the first day and would not cause major impacts.

A more comprehensive discussion occurs in the Impacts on Air Quality sections of USDOJ, MMS, Herndon (2002:Secs. 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, ozone levels, and atmospheric visibility all would be minor or negligible. Section V.C.13 of the Liberty final EIS (USDOJ, MMS, 2002) discusses the cumulative effects on air quality from all North Slope oil and gas activities since 1969. It concludes that the cumulative effects of all projects affecting that area in the past and occurring now generally have caused 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, Section IV.C.1.b of this EIS concludes that there would be a small, very localized increase in concentration of criteria pollutants from small oil spills, but the overall effects on air quality would be very low.

Total emissions from anticipated development under Alternative I would be from the installation of a central platform with processing facilities, construction of up to 150 mi of offshore pipeline, drilling of between 80 and 120 production wells and 20-40 service wells, installation of an onshore support facility and pump station, and constructions of up to 300 mi of onshore pipeline stretching eastward to the TAPS. In the peak years, a probable maximum of 20 wells per year would be drilled from two rigs, one on the platform and the other on a drillship. Peak-year production emissions would result from combined drilling operations and production operations producing about 200,000-250,000 bbl of oil per day and from transportation of that oil.

We could expect very little cumulative interaction between emissions from developments resulting from Alternative I and any other existing, planned, or potential oil or gas development projects. For the area as a whole, it is likely 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.

V.C.2.a. 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 State. 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 Action are small compared to the emissions from Prudhoe Bay and Kuparuk oil-field production.

V.C.2.b. Global Climate Change.

The global climate change analysis performed for the 5-Year Program (USDOJ, MMS, Herndon, 2002:Sec. 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 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). Because any production ensuing from Alternative I would tend to offset declining oil production from current North Slope fields, any increases in greenhouse-gas emissions would be minor. Also, because emissions from the actual combustion of oil products are much greater than the emissions from production operations, the effect on climate change from Alternative I would be negligible, as the level of oil consumed in the United States, with or without this Alternative, likely would not change.

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 from greenhouse-gas emissions would be very similar, regardless of the location of the energy source.

V.C.2.c. 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 VOC's also would occur during tanker loading and unloading operations. Emissions of nitrogen oxides and VOC's 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-recovery systems to substantially reduce VOC 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 VOC 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 IV.C.1.b of this EIS. Overall air quality impacts from transportation would be low.

Summary and Conclusions for Chukchi Sea Activities on Air Quality. The cumulative effects of all projects affecting the Chukchi Sea, Beaufort Sea, and North Slope areas 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 area projects would not change this situation. We also expect that no synergistic effects will affect air quality.

Contribution of Alternative I to Cumulative Impacts: Considering that predicted discoveries and development from Alternative I would represent only a small percentage of the existing North Slope activity, and would tend to offset declining production elsewhere, air emissions from Alternative I would have no significant cumulative effects on air quality. See Section IV.C.1.b for a discussion of these emissions.

V.C.3. Lower Trophic-level Organisms.

Lower trophic-level organisms do not migrate, as do seabirds and marine mammals, from the Chukchi to the adjacent lease areas in the Beaufort Sea, so the proposed Beaufort lease sales would not alter the level of effects on these Chukchi organisms. In contrast, climate change and the decreases in the summer ice cover will probably have measurable effects on these organisms in the Chukchi, as summarized in Section III.B.1. For example, the plankton blooms are more prolonged, and more like those in the Northern Bering Sea (Grebmeier et al., 2006). In the Bering, the relative importance of the benthos is lower, and the relative importance of pelagic consumers like fishes is higher. The cumulative effects of the proposed Chukchi lease sale are assessed in the context of climate change.

The cumulative disturbance effect of exploratory wells probably would be low, unless wells were located near any special biological communities; however, MMS would complete further environmental review of any installation proposals and could also require site-specific surveys to help identify seafloor resources. The cumulative effects of exploratory discharges during summer probably would be relatively low in deep offshore locations and slightly greater in the shallower nearshore portions of the proposed lease area. Water circulation under the winter ice cover is relatively slow, so we assume that produced water would be reinjected; regardless, the cumulative effects of any discharge proposals would be reviewed in detail by MMS and possibly USEPA. We assume that pipelines would radiate from any offshore production platforms, and that pipelines would extend to shore. Pipelines within the ice gouging zone would be buried. Installation of buried probably would disturb several thousand acres of typical benthos for less than a decade, leading to a moderate level of effect. The disturbance effects would be assessed and probably monitored by the pipeline company, MMS, or the U.S. Army Corps of Engineers. The effects of an alternative to production pipelines—the transportation of produced oil in vessels—could pose a much greater spill risk than that presented for this scenario. The Oil-Spill-Risk Analysis (OSRA) model estimates the chance of one or more large spills greater than or equal to (\geq) 1,000 bbl occurring over the production life of the field, and the low chance that such spills would contact the U.S. coastline within 3 days. If oil did contact this coastline, the oil probably would persist in a few of the tidal and subtidal sediments for a couple decades, leading to a moderate lower trophic impact. The chance of large spills contacting the coastline increases within 30 days, demonstrating the advantages of requirements for rapid-response capability. During the abandonment phase, we assume that offshore pipelines would be cleaned, plugged, and abandoned in place. Anchoring associated with coastwise and maritime traffic, and any discharges from local communities have the potential for local impacts on benthic and other lower trophic-level organisms. The environmental changes associated with Arctic climate change have the potential to impact lower trophic-level organisms in the Chukchi Sea region, making them more like the organisms in the Northern Bering Sea (Sec. III.B.1). Overall, the cumulative level of effect on lower trophic-level organisms with standard mitigation would be moderate, and the level would be minor with requirements for rapid spill response capability.

Contribution of Alternative I to Cumulative Impacts. The Proposed Action would represent a small percentage of the foreseeable cumulative activities. Activities resulting from the sale are not projected to contribute significantly to cumulative effects on lower trophic-level organisms.

V.C.4. Fish Resources.

The cumulative effect of seismic exploration on fish resources probably would be minor. The cumulative effect of disturbance due to seafloor sampling and drilling platforms also probably would be minimal; regardless, the MMS would review further any installation proposals. The cumulative effect of exploratory discharges probably would lead to low effects in offshore locations. The year-round discharge of produced water anywhere probably would lead to moderate effects. Discharges in nearshore Arctic Ocean waters have not been approved by USEPA, but any discharge proposals would be reviewed in detail by MMS and USEPA. We assume an extensive system of pipelines for offshore development that would disturb several thousand acres of typical benthos for less than a decade, depending on specific location, which could lead to a moderate effect. The disturbance effects would be reviewed further by MMS and the U.S. Army Corps of Engineers, but we also

assume that the effects of an alternative to production pipelines—the transportation of produced oil in vessels—could be much worse. The OSRA model estimates that the mean number of large offshore spills $\geq 1,000$ bbl during the production life of the fields would be 0.96 (Table V-1). If oil from such spills contacted the Chukchi Sea/Arctic Ocean coastline, the oil probably would persist in the tidal and subtidal sediments for a couple decades, leading to a significant long-term impact to nearshore habitats to spawning and rearing fish. During the abandonment phase, we assume that the offshore pipelines would be cleaned, plugged, and abandoned in place. For purposes of analysis, one large spill was assumed to occur and is analyzed in this EIS. Overall, the cumulative level of effect on fish resources would be moderate in most cases. A large oil spill likely would impact certain spawning and rearing habitats for decades. These impacts could result in varying degrees of population-level effects to different species, including the loss of several discrete runs of pink, chum, and coho salmon along the Chukchi Sea coast.

Subsistence fishing, coastwise and maritime traffic, and any discharges from local communities have the potential for local impacts on fish resources. There is no commercial fishing in the Sale 193 area and little recreational fishing. The environmental changes associated with Arctic climate change have the greatest potential to impact fish resources in the Chukchi Sea region.

Contribution of Alternative I to Cumulative Impacts. The Proposed Action would represent a small percentage of the foreseeable cumulative activities. Activities resulting from the sale are not projected to contribute significantly to cumulative effects on fish resources.

V.C.5. Essential Fish Habitat.

The cumulative effect of seismic exploration on Essential Fish Habitat (EFH) probably would be minimal. The cumulative effect of disturbance due to seafloor sampling and drilling platforms also probably would be minimal; regardless, MMS would review further any installation proposals. The cumulative effect of exploratory discharges probably would lead to low effects in offshore locations. The year-round discharge of produced water anywhere probably would lead to minor effects. Discharges in nearshore Arctic Ocean waters have not been approved by USEPA, but any discharge proposals would be reviewed in detail by MMS and USEPA. We assume an extensive system of pipelines for offshore development that would disturb several thousand acres of typical benthos for less than a decade, depending on specific location, could lead to a moderate, short-term effect on nearshore EFH. The disturbance effects would be reviewed further by the MMS and the U.S. Army Corps of Engineers, but we also assume that the effects of an alternative to production pipelines—the transportation of produced oil in vessels—would be much worse. The OSRA model estimates that the mean number of large offshore spills $\geq 1,000$ bbl during the production life of the fields would be 0.96 (Table V-1). If oil from such spills contacted the Chukchi Sea/Arctic Ocean coastline, the oil probably would persist in the tidal and subtidal sediments for a couple decades, leading to a significant long-term impact to EFH. During the abandonment phase, we assume that offshore pipelines would be cleaned, plugged, and abandoned in place. For purposes of analysis, one large spill was assumed to occur and is analyzed in this EIS. Overall, the cumulative level of effect on EFH would be minimal to moderate. A large oil spill, however, likely would impact certain spawning and rearing habitats for decades.

Subsistence fishing, coastwise and maritime traffic, and any discharges from local communities have the potential for local impacts on EFH. The environmental changes associated with Arctic climate change have the potential to impact EFH in the Chukchi Sea region.

Contribution of Alternative I to Cumulative Impacts. The Proposed Action would represent a small percentage of the foreseeable cumulative activities. Activities resulting from the sale are not projected to contribute significantly to cumulative effects on EFH.

V.C.6. Threatened and Endangered Species

V.C.6.a. Threatened and Endangered Marine Mammals.

Information in this section about the potential cumulative impacts associated with oil and gas activities in the Proposed Action area is gleaned from MMS's Arctic Region Biological Evaluation (dated March 3, 2006, and available at <http://www.mms.gov/alaska/cproject/cproject.htm>), which addressed the overall effects of oil and

gas exploration, development, and production in the Arctic Ocean and was submitted to the NMFS, per Section 7 requirements of the ESA.

Cumulative effects are defined differently under Section 7 of the ESA than under NEPA. Under the ESA (50 CFR 402.02, Interagency Cooperation on the ESA of 1973, as amended) cumulative effects include future State or private activities not involving Federal activities that are reasonably certain to occur within the area of the Federal action subject to consultation. For purposes of interagency consultations, an environmental baseline is defined as the past and present impacts of all Federal, State, or private actions and other human activities in an action area; the anticipated impacts of all proposed Federal projects in an action area that have already undergone formal or early Section 7 consultation; and the impact of State or private actions that are contemporaneous with the consultation in process [50 CFR §402.02].

V.C.6.a(1) Bowhead Whales. The potential for cumulative effects from oil and gas activities in the Proposed Action area to adversely affect bowhead whales is of concern because of their current endangered status and importance as a subsistence species to Alaskan Native residents of coastal villages adjacent to their range, and because of their unusual ecology, which obligates their use of a relatively restrictive area during calving and spring migration.

The following types of past, present, and reasonably foreseeable actions and factors have contributed to the environmental baseline conditions in the Chukchi Sea and could contribute to potential cumulative effects on the Western Arctic stock of bowhead whales:

- historic commercial whaling
- subsistence hunting
- activities related to offshore oil and gas exploration and development
- commercial fishing and marine vessel traffic
- climate change
- activities
- pollution and contaminants

Several documents have become available recently that are particularly useful as sources of information about potential cumulative effects on this population and the potential significance of effects on the status and health of this population. These include: the International Whaling Commission's (IWC's) Scientific Committee's in-depth assessment of Bering-Chukchi-Beaufort (BCB) Seas stock of bowhead whales (IWC, 2004b); NMFS' *Biological Opinion on Issuance of Annual Quotas Authorizing the Harvest of Bowhead Whales to the Alaska Eskimo Whaling Commission for the Period 2003 through 2007* (NMFS, 2003a); NMFS's *Final Environmental Assessment for Issuing Subsistence Quotas to the Alaska Eskimo Whaling Commission for a Subsistence Hunt on Bowhead Whales for the Years 2003 through 2007* (NMFS, 2003b); papers evaluating whether this population should be delisted (Shelden et al., 2001, 2003; Taylor, 2003); and the National Research Council's (NRC's) report *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope* (NRC, 2003b). The IWC reviewed and critically evaluated new information available on the bowhead whale at their 2005 meeting (IWC, 2005a,b). This information and the associated discussions are summarized in the *Report of the Subcommittee on Bowhead, Right and Gray Whales* (IWC, 2005b). The 2003 Alaska Marine Mammal Stock Assessment for this stock remains the most recent finalized stock assessment available but an updated draft 2005 Stock Assessment is available for consideration (Angliss and Outlaw, 2005).

There are no data available that indicate that, other than historic commercial whaling, any previous human activity has had a significant population-level adverse impact on the current status of BCB Seas bowhead whale or their recovery. Currently available information indicates that at the population level, bowhead whales that use the Proposed Action area are resilient at least to the level of human-caused mortality and disturbance that currently exists within their range and has existed since the cessation of commercial whaling. Data indicate that at least some bowheads are extremely long-lived (100+ years or more) (C. George, as cited in U.S. Dept. of Commerce, 2002). Thus, many of the individuals in this population already may have been exposed to a high number of disturbance events in their lifetimes.

The primary known current human-related cause of mortality is a regulated subsistence hunt by Alaskan Natives, which occurs at different times of the year in many of the coastal portions of their range. Because the level of take is directly linked to the population abundance and status of this population, protection of the

availability of whales for subsistence take is linked to protection needed to ensure the long-term viability of the population. Whether there are long-lasting behavioral effects from this activity are unknown, but overall habitat use appears to be relatively unaffected. See Section V.C.12 for a discussion of cumulative impacts associated with the subsistence harvest of bowhead whales.

Available information does not indicate that the cumulative effects of all other past or currently occurring noise and disturbance-causing factors combined (e.g., oil and gas activities, shipping, subsistence hunting, and research activities); habitat-alteration activities (e.g., gravel island construction, port construction); or local or distant pollution has had any long-lasting physiological, or other adverse effect(s) on the population. The factors related to the variability in bowhead responsiveness to anthropogenic noise are unclear and other populations are not as well studied. It also is unclear whether there is a human-related cause underlying the high level (at least in some instances) of behavioral responsiveness to human noise of the bowhead whale. There are not sufficient data about past human activities, including, but not limited to, past offshore oil and gas-related seismic surveys, or ice-management activities, to address whether there are any long-term impacts on their behavior from such activities in either evaluation area.

V.C.6.a(2) Introductory Information Relevant to Evaluation and Interpretation of Potential Cumulative Effects on Bowheads. Because the potential effects of some specific perturbations (large oil spills, repeated exposure to noise, shipping, etc.) are uncertain, an even greater level of uncertainty exists about the cumulative impact of all of the potential factors, especially over the long timeframes that must be considered for this species.

While such uncertainty exists about the details of some but not all cumulative effects, it also is the case that the Western Arctic stock of bowheads is relatively very well studied and monitored. The overall current status of this population is not uncertain, despite the inherent uncertainty associated with some factors that might have had, or might be having, some adverse (or even positive) effects on it. Because some of the potential cumulative effects on this population are highly regulated (e.g., subsistence hunting), the level of at least some effects are clearly known. However, data on other potential perturbations (e.g., past seismic surveys and oil spills) are not sufficient to clearly know the level of effects.

V.C.6.a(3) Historical Commercial Whaling. Commercial hunting between 1848 and 1915 caused severe depletion of the bowhead population(s) that inhabits the Bering, Chukchi, and Beaufort seas. This hunting is no longer occurring and is not expected to occur again. Woody and Botkin (1993) estimated that the historic abundance of bowheads in this population was between 10,400 and 23,000 whales in 1848, before the advent of commercial whaling. Woody and Botkin (1993) estimated between 1,000 and 3,000 animals remained in 1914, near the end of the commercial-whaling period. Data indicate that what is currently referred to as the Western Arctic stock (by NMFS) or as the BCB Seas stock (by the IWC) of bowheads is increasing in abundance and has increased in abundance substantially since the last ESA consultation between MMS and NMFS involving the Chukchi Sea OCS Planning Area. Scientific analyses indicate that BCB Seas bowhead whales may have reached, or are approaching, the lower limit of their historic population size. There are related analyses supporting its removal from the list of threatened and endangered species.

V.C.6.a(4) Subsistence Hunting. Indigenous peoples of the Arctic and Subarctic of what is now Alaska have been hunting bowhead whales for at least 2,000 years (Stoker and Krupnik, 1993). Thus, subsistence hunting is not a new contributor to cumulative effects on this population. There is no indication that, prior to commercial whaling, subsistence whaling caused significant adverse effects at the population level. However, modern technology has changed the potential for any lethal hunting of this whale to cause population-level adverse effects if unregulated. Under the authority of the IWC, the subsistence take from this population has been regulated by a quota system since 1977. Federal authority for cooperative management of the Eskimo subsistence hunt is shared with the Alaska Eskimo Whaling Commission (AEWC) through a cooperative agreement between the AEWC and the United States Department of Commerce, National Oceanic and Atmospheric Administration (NMFS, 2003b).

The sustainable take of bowhead whales by indigenous hunters represents the largest known human-related cause of mortality in this population at the present time. Available information suggests that it is likely to remain so for the foreseeable future. While other potential effectors primarily have the potential to cause, or to be related to, behavioral or sublethal adverse effects to this population, or to cause the deaths of a small number of individuals, little or no evidence exists of other common human-related causes of mortality. Subsistence

take, which all available evidence indicates is sustainable, monitored, managed, and regulated, helps to determine the resilience of the population to other effectors that potentially could cause lethal takes. The sustained growth of the BCB Seas bowhead population indicates that the level of subsistence take has been sustainable. Because the quota for the hunt is tied to the population size and population parameters (IWC, 2003a; NMFS, 2003b), it is unlikely this source of mortality will contribute to a significant adverse effect on the recovery and long-term viability of this population.

There are adverse impacts of the hunting to bowhead whales in addition to the death of animals that are successfully hunted and the serious injury of animals that are struck but not immediately killed. Available evidence indicates that subsistence hunting causes disturbance to the other whales, changes in their behavior, and sometimes temporary effects on habitat use, including migration paths. Modern subsistence hunting represents a source of noise and disturbance to the whales during the following periods and in the following areas: during their northward spring migration in the Bering Sea, the Chukchi Sea in the Spring Lead System (SLS), and in the Beaufort Sea SLS near Barrow; their fall westward migration in subsistence hunting areas associated with hunting from Kaktovik, Cross Island, and Barrow; hunting along the Chukotka coast; hunting in wintering areas near St. Lawrence Island. Lowry, Sheffield, and George (2004) reported that indigenous hunters in the Beaufort Sea sometimes hunt in areas where whales are aggregated for feeding.

When a subsistence hunt is successful, it results in the death of a bowhead. Data on strike and harvested levels indicate that whales are not always immediately killed when struck, and some whales are struck but cannot be harvested. Whales in the vicinity of the struck whale could be disturbed by the sound of the explosive used in the hunt, the boat motors, and any sounds made by the injured whale. The NMFS (2003b) pointed out that whales that are not struck or killed may be disturbed by noise associated with the approaching hunters, their vessels, and the sound of bombs detonating: "...the sound of one or more bombs detonations during a strike is audible for some distance. Acousticians listening to bowhead whale calls as part of the census, report that calling rates drop after such a strike..." (NMFS, 2003b). Data are lacking about how far hunting-related sounds (e.g., the sounds of vessels and/or bombs) can propagate in areas where hunting typically occurs, but this is likely to vary with environmental conditions. It is not known if a whale issues an "alarm call" or a "distress call" after it, or another whale, is struck prior to reducing call rates.

Because evidence indicates that bowhead whales are long-lived, some bowhead whales may have been in the vicinity where hunting was occurring on multiple, perhaps dozens or more, occasions. Thus, some whales may have cumulative exposure to hunting activities. This form of noise and disturbance adds to noise and disturbance from other sources, such as shipping and oil- and gas-related activities. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (e.g., hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale-habitat use. However, information about long-term habitat avoidance occurring with present levels of activity is not available. Additionally, if, as reported above, whales become more "skittish" and more highly sensitized following a hunt, it may be that their subsequent reactions over the short-term to other forms of noise and disturbance are heightened by such activity. Data are not available that permit evaluation of this possible, speculative interaction.

Noise and disturbance from subsistence hunting serve as a seasonally and geographically predictable source of noise and disturbance added to by other noise and disturbance sources, such as shipping and oil- and gas-related activities. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (e.g., hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale-habitat use. Subsistence hunting attaches a strong, adverse association to human noise for any whale that has been in the vicinity when other whales were struck.

In summary, it is not unlikely that up to 82 (67 + 15) whales may be struck (with the presumption that they could die, even if not retrieved) in a given year from 2004 through 2007, as long as a total of 280 is not exceeded over the 5-year period. If the population of whales continues to increase in abundance, it is not unlikely that this quota could be increased for the next 5-year period (2008-2012). However, it also is likely that the quota will continue to be a small percentage of the estimated population size and will not have significant adverse impacts on the population. The subsistence take, while additive, actually is small as compared to the capacity of the population to absorb it and to thrive. No potential human-related effects that approach, or could reasonable be predicted to approach, the level of this known removal are known. This activity also results in noise and disturbance that may have temporary effects on habitat use. We are not aware of information suggesting there have been any long-term modifications of habitat use due to this form of noise

and disturbance. However, we also emphasize that the hunt is highly regulated, has limits on take, and places direct prohibition on the take of females with calves. Other potential effecters have less controllable effects, unless also purposely mitigated and shaped.

The existence of this hunt results in a relatively high level of Native, local, State, national, and international study, monitoring, and management of this population(s) which provides some safeguards for its long-term viability. Mitigations that are focused on protecting the hunt may have the unintended effect of increasing overall impacts on the whales by focusing other (e.g., industrial) activities into periods and places that may act as temporary hunting refuges for the whales unless MMS and NMFS also deliberately design mitigations to offset such an impact.

V.C.6.a(5) Climate Change. Cumulatively, climate change potentially could affect bowhead whales in ways including:

- increased noise and disturbance related to increased shipping, and possibly related to increased development, within their range;
- increased interactions with commercial fisheries, including increased noise and disturbance, incidental take, and gear entanglement;
- decreases in ice cover with the potential for resultant changes in prey-species concentrations and distribution; related changes in bowhead whale distributions; changes in subsistence-hunting practices that could result in smaller, younger whales being taken and, possibly, in fewer whales being taken;
- more frequent climatic anomalies, such as El Niños and La Niñas, with potential resultant changes in prey concentrations; and
- a northern expansion of other whale species, with the possibility of increased overlap in the northern Bering and/or the Chukchi seas.

The IUCN /Species Survival Commission (IUCN/SSC) (IUCN, 2003) concluded that the effects of climate change are complex and interactive, making them analytically almost intractable and that there are difficulties in establishing direct links between climate change and the health of individual cetaceans, or indirect links between climate change and the availability of cetacean prey. With respect to observations and conclusions specifically pertinent to bowhead whales, the SEARCH SSC (2001) noted that available data point to long-term and recently augmented reductions in sea-ice cover (Maslanki, Serreze, and Barry, 1996; Bjorgo et al., 1997; Cavalieri et al., 1997; Zakharov, 1997; Rothrock, Yu, and Maykut, 1999), and perhaps most alarming, there have been significant reductions in sea ice extent (Parkinson et al., 1999) and a 43% reduction in average sea-ice thickness (Rothrock, Yu, and Maykut, 1999) in recent decades.

Angliss and Lodge (2002:174) stated that:

Ice-associated animals, such as the bowhead whale, may be sensitive to changes in Arctic weather, sea-surface temperatures, or ice extent, and the concomitant change on prey availability. There are insufficient data to make reliable predictions of the effects of Arctic climate change on bowhead whales.

In 2005, a symposium *High Latitude Sea Ice Environments: Effects on Cetacean Abundance, Distribution and Ecology* was held as a pre-meeting to the IWC Annual meeting in 2005 (IWC, 2005a). At this symposium, MMS identified the following concerns, as stated in the Beaufort Sea Lease Sale 195 Biological Evaluation (USDOI, MMS, 2004): increased exposure of bowhead whales to killer whale predation; competition with other species; ship traffic; noise; pollution; and fisheries interactions. In addition, a reduction in sea ice may affect the logistics of the harvest and raised concerns about thermoregulatory issues. The IWC Scientific Committee (IWC, 2005a) summarized that: "...the Committee...found it difficult to predict how bowhead whales might be affected by large-scale oceanographic changes in the future."

If climate changes occur, it is likely that shipping would increase throughout the range of the bowhead, especially in the southern portions of the Arctic Ocean. If commercial fisheries were to expand, bowhead whale death and or injury due to interactions with fishing gear, possibly injury and/or death due to incidental take in commercial fisheries, and temporary effects on behavior potentially could occur. There are, however, no data that would permit a quantitative prediction of the aforementioned possible effects.

Based on our previous and continued review of available information, MMS agrees with the aforementioned general conclusions. However, MMS believes that evidence is accumulating that increased noise and disturbance in bowhead summer, autumn, and potentially spring habitat due to increased shipping and industrial activity that occurs as a result of climate warming has begun to occur and is likely to continue.

The MMS concludes that the potential effects of climate change on the bowhead whale population are uncertain, and there is no current evidence of negative effects from climate change on the whales. Shelden et al. (2003) state that:

Although available data do indicate that the Bering Sea environment is changing (e.g., Angel & Smith 2002), we are aware of no evidence that environmental changes will be detrimental to the population in the foreseeable future. In fact, our review...on this issue suggests that climate change may actually result in more favorable conditions for BCB bowheads.

V.C.6.a(6) Commercial Fishing, Marine Vessel Traffic, and Research Activities. Based on available data, previous incidental take of bowhead whales apparently has occurred only rarely as a result of commercial fishing, marine vessel traffic, and research activities.

Potential effects on bowhead whales from commercial-fishing activities include incidental take in the fisheries and/or entanglement in derelict fishing gear resulting in death, injury, or effects on the behavior of individual whales; disturbance resulting in temporary avoidance of areas; and whales being struck and injured or killed by vessels. Bowheads have been entangled in ropes from crab pots, harpoon lines, or fishing nets; however, the frequency of occurrence is not known.

The bowhead's association with sea ice limits the amount of fisheries activity occurring in bowhead habitat. However, as noted in the section on climate change, the frequency of such interactions in the future would be expected to increase if commercial-fishing activities should expand northward from the Bering Sea. The result would be increases in temporal and, especially, spatial overlap between commercial-fishing operations and bowhead habitat use. Increases in spatial overlap alone could result in increased interactions between bowheads and derelict fishing gear.

Marine vessel traffic, in general, can pose a threat to bowheads because of the risk of ship strikes. Available evidence indicates that bowheads either do not often encounter vessels or they avoid interactions with vessels, or that interactions usually result in the animals' death. The NMFS (2003b) reports that the rate of ship strikes may have increased slightly in recent years.

Noise associated with ships or other boats potentially could cause bowheads to alter their movement patterns or make other changes in habitat use. Clapham and Brownell (1999) summarized that "...effects of ship noise on whale behavior and ultimately on reproductive success are largely unknown." The NMFS (2003b) concluded that the greatest potential impact to bowhead whales from research in the Arctic was from underwater noise generated by icebreakers. They cite the Western Arctic Shelf Basin Interactions (SBI) project, which operated from the U.S. Coast Guard *Healy* and *Polar Star* icebreakers. This was a multiyear, interdisciplinary program aimed at investigating the impacts of climate change on biological, physical, and geochemical processes in the Chukchi and Beaufort Shelf Basin in the Western Arctic Ocean.

Richardson et al. (1995a) reported estimated source levels for similarly sized icebreakers to range from 177-191 db re 1 μ Pa-m. During icebreaking, extremely variable increases in broad-band (10-10,000 Hertz [Hz]) noise levels of 5-10 decibels (dB) are caused by propeller cavitation. Based on previous studies of bowhead response to noise, such sound could result in temporary avoidance of animals from the areas where the icebreakers were operating and potentially cause temporary deflection of the migration corridor, depending of the location of the icebreakers. SEARCH SSC (2001) (citing Brigham, 1998, 2000) point out that from 1977-1998, there have been 27 icebreaker trips to the North Pole (presumably not all in the range of this stock of bowhead) for science and tourism.

Richardson et al. (1995a) concluded that: "Ships and larger boats routinely use fathometers, and powerful side-looking sonars are common on many military, fishing, and bottom-survey vessels.... Sounds from these sources must often be audible to marine mammals and apparently cause disturbances in some situations."

There has been speculation recently that commercial shipping through the Northwest Passage is likely to substantially increase in the coming decades. Many shipping experts believe that “in-and-out” shipping (e.g., shipping from the Pacific Ocean or Bering Sea through the Chukchi Seas into the Beaufort and then back again) is likely to increase well in advance of regular shipping through the Northwest Passage.

The Western Arctic bowhead has been the focus of research activities that, in some instances, could cause minor temporary disturbance of the whales. During research on the whales themselves, the reactions of the whales generally are closely monitored to minimize potential adverse effects. Additionally, research conducted primarily for reasons other than the study of the bowhead also has occurred within the range of the bowhead. In some cases, such research has the potential to adversely affect the whales through the introduction of additional noise, disturbance, and low levels of pollution into their environment. Research vessels also sometimes introduce noise intentionally, not just incidentally, into the environment as part of the ship’s operating systems or to enable the collection of specific types of data (e.g., seismic-survey data).

Submarines are highly valued platforms for a variety of oceanic research in part because they are relatively quiet, enabling the use of active and passive acoustic technologies for a variety of studies. Information about the response of bowheads to resting or transiting submarines is not available to MMS. U.S. Navy submarines are likely to continue to be used as platforms in the future.

Alaskan Native whalers have concerns that barge traffic associated with oil and gas activities might have caused bowhead whales to move farther offshore and, thus, to be less accessible to subsistence hunters.

The MMS concludes that some past and present research-related noise and disturbance could potentially have caused, and can cause, harassment and, possibly, temporary displacement of individual whales. Such noise and disturbance add to cumulative levels of noise in the whales’ environment. At present, available information does not indicate that such noise is having behavioral or physiological adverse effects on the bowheads in this stock. However, available information is not sufficient to form any conclusions about such potential effects. The MMS is not aware of any information that suggests long-term displacement from important habitats has occurred, that indicates the population is suffering any significant population-level effect from any single affecter, or that indicates that the cumulative effects, including those from research activities, would have such an effect.

V.C.6.a(7) Pollution and Contaminants. Polluted discharge from marine vessel traffic, especially from large vessels such as large cruise ships, oil spills, and discharges from exploration, development, and production activities could cause degradation of the marine environment and increase the risk of the bowhead whales’ exposure to contaminants and disease vectors.

Initial studies of bowhead tissues collected from whales landed at Barrow in 1992 (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. 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 being 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. 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, and 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. The study went on to recommend 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 ¹³⁷Cs. 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.

Based on the use of autometallography (AMG) to localize inorganic mercury in kidney and liver tissues for five bowhead whales, Woshner et al. (2002) reported that “AMG granules were not evident in bowhead tissues, confirming nominal mercury (Hg) concentrations.” Detected concentrations ranged from 0.011-0.038 micrograms per gram wet weight for total mercury. Mössner and Ballschmiter (1997) reported that total levels of 310 nanograms per gram (ng/g) polychlorinated biphenyls and chlorinated pesticides in bowhead blubber from the North Pacific/Arctic Ocean, an overall level many times lower than that of other species from the North Pacific or Arctic Ocean. However, while total levels were low, the combined level of three isomers of the hexachlorocyclohexanes was higher in the bowhead blubber (160 ng/g) tested than in either the pilot whale (47 ng/g), the common dolphin (130 ng/g), and the harbor seal (140 ng/g). These results confirmed results expected due to the lower trophic level of the bowhead relative to the other marine mammals tested.

In MMS’ Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a), it was concluded that the levels of metals and other contaminants measured in bowhead whales appear to be relatively low, with the exception of cadmium. Since the finalization of that EIS, the additional aforementioned information on contaminants in BCB Seas bowheads supports this same general conclusion.

V.C.6.a(8) Offshore Oil- and Gas-Related Activities and other Industrial Activities. Offshore petroleum exploration, development, and production activities have been conducted in Alaska State waters or on the Alaska OCS in the Beaufort and Chukchi seas since 1979. The MMS-permitted seismic surveys have been conducted in the Chukchi and Beaufort seas since the late 1960’s and early 1970’s. Much more seismic activity has occurred in the Beaufort Sea OCS than in the Chukchi Sea OCS. Compared to the North Slope/Beaufort Sea, there has been little oil- and gas-related activity in the Chukchi Sea. Many offshore activities required ice management (icebreaking), helicopter traffic, fixed-wing monitoring, other support vessels and, in some cases stand-by barges.

Past behavioral (primarily, but not exclusively, avoidance) effects on bowhead whales from oil and gas activity have been documented in many studies. Inupiat whalers have stated that noise from seismic surveys and some other activities at least temporarily displaces whales farther offshore, especially if the operations are conducted in the main migration corridor. As noted in the section on effects, recent monitoring studies indicated that most fall migrating whales avoid an area with a radius about 20-30 km around a seismic vessel operating in nearshore waters; however, there are no data that indicate that such avoidance is long-lasting after cessation of the activity.

Available data, however, are inadequate to fully address issues about effects of past oil and gas activity specifically in the Chukchi Sea on bowhead behavior. However, comparative information exists about such development in the nearby and more developed Beaufort Sea area. The MMS study 2002-071 titled *GIS Geospatial Data Base of Oil-Industry and Other Human Activity (1979-1999) in the Alaskan Beaufort Sea* provided a compilation of available data on the location, timing, and nature of oil- and gas-related activities from 1979-1999. It was intended to provide a data base to address concerns expressed by subsistence hunters and others living within villages of the Beaufort Sea about the possible effects that oil and gas activity, particularly seismic activity, drilling, and oil and gas support vessel activities may have on the behavior of the bowhead whale. However there are significant gaps in the data for the period 1979-1989 and very limited information was obtained on ice management (Wainwright, 2002). Thus, while data on the bowhead status are adequate to determine that the BCB Seas bowhead whale population apparently continued to recover during the periods when past and current levels of oil and gas activities were occurring, we cannot adequately assess potential effects on patterns or durations of bowhead habitat use. Because of the inadequacy of the data on activities, and because of the limitations inherent in studying large baleen whales, MMS was not able to assess whether there were any adverse health effects to individuals during the period of relatively intensive seismic survey activity in the 1980’s.

Data for the 1990’s are better, and the levels of activity are more comparable to those anticipated in the near future. Wainwright (2002) gives information about the kinds and levels of seismic and acoustic activity in the 1990’s and there were no geohazard (high-resolution seismic surveys) surveys during the fall migration period in the 1990’s. Except in 1990 and 1998, seismic surveying activity was completed by September 30, and most

of the activity was between September 1 and September 15. During 3 of the years, there was no seismic surveying activity during the fall migration period.

Data on past drilling in both Federal and State waters is relatively complete, especially since 1990 Wainwright (2002). Data on other activities, such as hunting activity, barge traffic, and shipping noise are incomplete. Thus, while it is clear there have been multiple noise and disturbance sources in the Beaufort Sea over the past 30 years, because of the incompleteness of data, even for the 1990's, for many types of activities, we cannot evaluate the cumulative effects on bowhead whales resulting from multiple noise and disturbance sources (e.g., 2D seismic in State and Federal waters, drilling, ice management, high-resolution acoustic surveys, vessel traffic, construction, geotechnical borehole drilling, aircraft surveys, and hunting). Because data also are incomplete for the Chukchi Sea, we reach the same general conclusions.

V.C.6.a(7)(a) Potential Impacts of Noise from Production Facilities. It has been documented that bowhead and other whales avoid various industrial activities if the received sound levels associated with the activity are sufficiently strong (Richardson et al., 1995a; NRC, 2003). The monitoring of sound associated with the construction and production activities at the BPXA Northstar facility and the monitoring of marine mammals in nearby areas has recently provided additional information relative to assessing potential impacts of oil and gas production-related noise on bowhead whales. Northstar is built on an artificial gravel island in State of Alaska waters about 54 mi (87 km) northeast of Nuiqsut. No artificial gravel islands are proposed to be constructed in the Chukchi Sea because of the sea's deep water. To date, it is the only offshore oil production facility north of the barrier islands in the Beaufort Sea. No offshore oil production facilities exist in the Chukchi Sea. See Section IV.C.1.f for a more thorough discussion about the effects of noise on threatened and endangered marine mammals.

Even though the Northstar facility is on an artificial island in the Beaufort Sea, many of the issues surrounding the facility are applicable to oil and gas development in the Chukchi Sea. North Slope residents have expressed concern that the bowhead whale autumn-migration corridor might be deflected offshore in the Northstar area due to whales responding to underwater sounds from construction, operation, and vessel and aircraft traffic associated with Northstar. Richardson and Thompson (2004) and other researchers working with LGL and Greeneridge Sciences, Inc. undertook studies during the open-water period to determine both the underwater noise levels at various distances north of Northstar and potential impacts on bowhead whales north of the island, as assessed by locations determined by vocalization locations. Blackwell and Greene (2004) summarized that, in the absence of boats, "During both construction...and the drilling and production phase..., island sounds...reached background values at distances of 2-4 km..." in quiet, ambient conditions. During the normal "open water period" in 2001 (June 16 to October 31), there were approximately 989 roundtrip helicopter flights to Northstar. Richardson et al. (2004) summarized that data in 2001 provided evidence of a slight displacement of the southern edge of the bowhead whale migration corridor at times with high levels of industrial sound, but no such effect was evident in 2003, and the 2002 results were inconclusive. However, the available data on bowhead locations, coupled with data on noise propagation, indicate that if noise from Northstar is having an impact on whale movements, the effect, if it exists, is not dramatic.

V.C.6.a(8) Future Activities. Potential cumulative effects to bowhead whales from near-term future oil and gas activities could include behavioral responses to seismic surveys; aircraft and vessel traffic; exploratory drilling, and production that take place at varying distances from the whales. It also could include effects from small and large oil spills (if a large oil spill were to occur). In general, bowheads may try to avoid vessels or seismic surveys if closely approached, but they do not respond very much to aircraft flying overhead at 1,000 ft or more. Bowheads attempt to avoid close approaches by motorized vessels. The response of individual bowheads to sound, such as drillship sounds, is variable (e.g., Richardson, Wells, and Würsig, 1985; Richardson and Malme, 1993). 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 12-24 hours for avoidance (for seismic activity). In some other species, responsiveness is linked to both context and to the sex and/or reproductive status of the animal. For example, in studies in Australia, humpback whale females with calves show greater avoidance of operating seismic boats than do males. Detailed discussions of how these various activities may affect bowheads can be found in the effects section above.

Overall, bowhead whales exposed to noise-producing activities associated with offshore oil and gas exploration and production activities would be most likely to experience temporary, nonlethal behavioral effects such as avoidance behavior. Effects could potentially be longer term, if sufficient oil and gas activity were to occur in a localized area.

The IWC Scientific Committee (IWC, 2005a:45) received an update on and discussed noise pollution (including seismic surveys), the limitations of mitigation measures, and the use of alternative technology at their 2004 annual meeting. The scientific committee stated that: "Detail on the type, number and configuration of airguns is needed to evaluate source capabilities and the potential impact on cetaceans."

There is no indication that human activities (other than historic commercial whaling) have caused long-term displacement in bowheads. Available information indicates that there is some potential for a level of noise and/or related disturbance to be reached that would potentially have such an effect in local areas. Existing regulatory authority under both the MMPA and the ESA is sufficient to keep such a situation from occurring and to mitigate many of the potential impacts from noise and other disturbance.

Native hunters believe that there is potential for increased noise (for example, from shipping and/or oil and gas development) to drive whales farther from shore, decreasing their availability to subsistence hunters, and potentially reducing mortality from this source. If such an effect occurred, it could produce a countervailing effect to adverse effects on the whale population. As noted in the section on subsistence hunting, cumulative noise and disturbance associated with oil and gas activities, shipping, and subsistence hunting could potentially have an additive or even synergistic effect on bowhead whale habitat use. However, at present, we are aware of no other information that suggests such an effect would be likely to occur or that such effects have occurred.

Effects of a large oil spill in Federal or State waters would most likely result in nonlethal temporary or permanent effects. However, we reiterate that due to the limitations of available information and due to the limitations inherent in the study of baleen whales, there is uncertainty about the range of potential effects of a large spill on bowhead whales, especially if a large aggregation of females with calves were to be contacted by fresh oil. The NMFS has concluded that, given the abundance of plankton resources in the Beaufort Sea (Bratton et al., 1993), it is unlikely that the availability of food resources for bowheads would be affected. As summarized in the effects section, 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, or possibly exposure to high concentrations of freshly spilled oil, could kill or injure whales. Because of existing information available for other mammals regarding the toxic effects of fresh crude oil, and because of inconclusive results of studies on cetaceans after the EVOS, we are uncertain about the potential for mortality of more than a few individuals. Such potential probably is greatest if a large aggregation of feeding or milling whales, especially an aggregation containing relatively high numbers of calves, was contacted by a very large slick of fresh oil. Such aggregations occasionally have been observed in open-water conditions north of Smith Bay and Dease Inlet, near Cape Halkett and other areas.

Available information suggests that the potential for oil-industry activities outside of the Chukchi Sea to contribute to cumulative effects on this stock of bowhead whales is still limited. This remains the case. Industry has not expressed interest in the Norton Basin or Hope Basin Planning Areas. None of the Bering Sea area is currently open for leasing. The North Aleutian Basin Planning Area currently is under Presidential withdrawal from leasing. The MMS is considering whether to request amendment of the withdrawal to allow the North Aleutian Basin Planning Area to be included in the 2007-2012 5-Year Program.

In conclusion, available data do not indicate that noise and disturbance from oil and gas exploration and development activities since the mid-1970's had a lasting population-level adverse effect on bowhead whales. Data indicate that bowhead whales are robust, increasing in abundance, and have been approaching (or have reached) the lower limit of their historic population size at the same time that oil and gas exploration activities have been occurring in the Beaufort Sea and, to a lesser extent, the Chukchi Sea. However, data are inadequate to fully evaluate potential impacts on whales during this period, including the duration of habitat use effects or numbers and types of individuals that did not use high-use areas because of the activities. Oil and gas exploration activities, especially during the 1990's and early 2000's have been shaped by various mitigating measures and related requirements for monitoring. Such mitigating measures, with monitoring requirements, were designed to, and probably did, reduce the impact on the whales and on potential impacts on whale

availability to subsistence hunters. We assume future activities in Federal OCS waters will have similar levels of protective measures. However, we cannot be certain of what mitigating measures will be imposed in State waters or what the impacts of land-related support activities will be. We also note that the effectiveness of mitigations is not entirely clear, nor is it clear when, or if, the level of activity might become large enough to cause effects that are biologically significant to large numbers of individuals. Looking at each action separately indicates that there should not be a strong adverse effect on this population. Future activity in the OCS has the potential to contribute a substantial increase in noise and disturbance that will occur from oil and gas activities in state waters and on land as well as increase spill risk to this currently healthy population. It is not clear what the potential range of outcomes might be if multiple disturbance activities occur within focused areas of high importance to the whales.

Overall, seismic surveys are likely to result in some incremental cumulative effects to bowhead whales through the potential exclusion or avoidance of bowhead whales from feeding or resting areas and disruption of important associated biological behaviors. However, the impact analysis of the likely range of effects and the likelihood of exposures resulting in adverse behavioral effects supports a conclusion that the activities would result in no more than temporary adverse effects and less than stock-level effects. Mitigation measures imposed through the MMPA authorizations process are designed to avoid Level A Harassment (injury), reduce the potential for population-level significant adverse effects on bowhead whales, and avoid an unmitigable adverse impact on their availability for subsistence purposes. We also developed additional measures to help reduce the level of uncertainty during the conduct of the seismic-survey activities, which provide yet another level of mitigation and protection. Therefore, MMS concludes that seismic surveys, especially as mitigated under the Proposed Action alternatives, are not expected to add significantly to the cumulative impacts on bowhead whales from past, present, and future activities.

V.C.6.a(9) Fin Whales. The NMFS summarized that there are no known habitat issues that are of particular concern for this stock (Angliss, DeMaster, and Lopez, 2001; Angliss and Lodge, 2002). However, Perry, DeMaster, and Silber (1999a) listed the following factors possibly influencing the status of fin whales in the North Pacific: Offshore oil and gas development as a “Present or threatened destruction or modification of habitat” and Vessel collisions as an “Other natural or man-made factor.”

The possible influences of disease or predation and of overutilization are listed as “Unknown.” There is no evidence of subsistence take of fin whales in the Northeast Pacific (Angliss, DeMaster, and Lopez, 2001; Angliss and Lodge, 2002).

Most stocks of fin whales were depleted by commercial whaling (Reeves, Silber, and Payne, 1998) beginning in the second half of the mid-1800’s (Schmitt, de Jong, and Winter, 1980; Reeves and Barto, 1985). In the 1900’s, hunting for fin whales continued in all oceans for about 75 years (Reeves, Silber, and Payne, 1998). In 1965, Nemoto and Kasuya (1965) reported that fin and sei whales were the primary species taken in the Gulf of Alaska during Japanese commercial whaling in recent catches, and more than 150 fin whales were taken just south of the Kenai Peninsula. Other areas of high take were southeast Alaska, especially the offshore areas between Prince William Sound and Glacier Bay. Multiple smaller groups of fin whales were taken offshore of areas south of Kodiak Island and the Alaska Peninsula to Unimak Pass, and large numbers were taken throughout the northern Gulf in an area bounded on the south at approximately 53° N. latitude. Legal commercial hunting ended in the North Pacific in 1976. Documented human-caused mortality of fin whales in the North Pacific since the cessation of whaling is low.

Documented fishery interaction rates with fin whales are low in the North Pacific. However, the only information available for many fisheries in the Gulf of Alaska comes from self reporting by individual fishers. Based on the death in 1999 of a fin whale incidental to the Bering Sea/Aleutian Island groundfish fishery, NMFS estimates three mortalities in 1999 and an average yearly take of 0.6 [coefficient of variation (CV) = 1] between 1995 and 1999 (Angliss and Lodge, 2002). Based on the fact that there have not been known takes since that time, Angliss and Outlaw (2005) concluded that the total estimated mortality and serious injury incurred by this stock as a result of interactions with commercial fisheries is 0.

Reported instances of fin whale deaths due to vessel strikes are low. In the North Atlantic, there is documented effect on behavior from whale watching and other recreational boat encounters and from commercial-vessel traffic (Stone et al., 1992) and also evidence of habituation to increased boat traffic (Watkins, 1986).

The Bering Sea, including portions of the MMS North Aleutian Basin Planning Area (which is currently under Presidential withdrawal from leasing), is an area of high use by fin whales for feeding during many months of the year. The MMS is considering whether to request amendment of the withdrawal to allow the North Aleutian Basin Planning Area to be included in the 2007-2012 5-Year Program. If oil and gas leasing and related activities occur, then fin whales could be potentially impacted that same way as bowhead whales.

Overall, the Proposed Action is likely to result in some incremental contribution to effects on fin whales through the possible exclusion or avoidance from feeding or resting areas and possible disruption of important biological behaviors. These effects would be limited in scope due to the low level of fin whale occurrence in the Proposed Action area.

V.C.6.a(10) Humpback Whales. Potential cumulative effects on both the North Pacific stock and on the Western North Pacific stock warrant concern and monitoring because, based on the general category of factors specified as requiring consideration under the ESA, the following factors [as identified by as Perry, DeMaster, and Silber (1999b)] are possibly impacting the recovery of humpbacks in the North Pacific:

- entanglement in fishing gear as “Other natural or man-made factors” (Central Stock);
- vessel traffic and oil and gas exploration as types of “Present or threatened destruction or modification of habitat”(Central Stock); and
- whale watching, scientific research, photography, and associated vessel traffic as types of “Overutilization...” (Central Stock).

The threat of disease or predation as unknown.

Historic commercial whale hunting resulted in the depletion and endangerment of humpback whales. Prior to commercial hunting, humpback whales in the North Pacific may have numbered approximately 15,000 individuals (Rice 1978b). Unregulated hunting legally ended in the North Pacific in 1966. No subsistence take of humpbacks is reported from Alaska or Russia (Angliss and Lodge, 2002).

The NMFS (1991) reports that entrapment and entanglement in active fishing gear (O’Hara, Atkins, Ludicello, 1986) is the most frequently identified source of human-caused injury or mortality to humpback whales and it has been documented to have occurred in Alaska (von Zeigesar, 1984 cited in von Zeigesar, Miller, and Dahlheim, 1994). From 1984-1989, 21 humpbacks are known to have become entangled in gear (e.g. gill nets, seine nets, long lines or buoy lines, and unidentified gear) in Alaska.

During 1990-2000, six commercial fisheries within the range of the both the western and central North Pacific stocks were monitored: Bering Sea/Aleutian Island and Gulf of Alaska groundfish trawl, longline, and pot fisheries. One humpback was killed in the Bering Sea/Aleutian Island groundfish trawl fishery in 1998 and one in 1999. There are no records of humpbacks killed or injured in the fisheries in which fishers self report (Angliss and Lodge, 2002), but the reliability of such data is unknown. One entanglement is recorded in 1997 for a humpback in the Bering Strait (Angliss and Lodge, 2002). However, between 1996 and 2000, five entanglements of humpbacks from the Central North Pacific Stock were reported in Hawaiian waters. Table 27b of Angliss and Lodge (2003:157) gives a total of 34 humpbacks from the Central North Pacific Stock classified as being involved in a human-related stranding or entanglement between 1997 and 2001. The Alaska Scientific Review Group (2001) stated that 32 humpbacks were entangled in southeast Alaska in the past 5 years.

Perry, DeMaster, and Silber (1999b) summarized that humpbacks respond the most to moving sound sources (e.g., fishing vessels, low-flying aircraft) and the long-term displacement of humpbacks from Glacier Bay and parts of Hawaii may have occurred due to vessel-noise disturbance (Perry, DeMaster, and Silber, 1999b). Due to concerns about the impacts of helicopters in Hawaiian waters, helicopters are prohibited from approaching within a slant range of 1,000 ft or 305 m from humpbacks (NMFS, 1987). Noise on their wintering grounds from the ATOC and the Navy’s Low-Frequency Active Sonar program also are sources of concern for the central North Pacific stock (Angliss and Lodge, 2002). The NMFS (1991a) also lists noise and disturbance from whale-watching boats; industrial activities; and ships, boats, and aircraft as causes of concern for humpback whales.

Vessel collision also is of concern for humpbacks. The NMFS (1991) reported that at least five photographed humpbacks in southeastern Alaska had gashes and dents probably caused by vessel strikes. Vessel strikes have caused humpback mortalities in the California/Oregon/Washington stock (an average of 0.6 killed per year) (Barlow et al., 1997) and in the western Atlantic (Perry, DeMaster, and Silber, 1999b).

Perry, DeMaster, and Silber (1999b) reported that continued development of coasts and oil exploitation and drilling may lead to humpbacks avoidance of areas. In a Newfoundland inlet, two humpbacks with severe mechanical damage to their ears were found dead near a site of continued subbottom blasting (Ketten, Lien, and Todd, 1993; Lien et al., 1993; Ketten, 1995). The impacts of pollution and habitat degradation due to coastal development are not known. In Hawaii, harbor and boat-ramp construction, vessel moorings, water sports, increased boat traffic, dumping of raw sewage by boats, runoff and overflow of sewage from land sites, and agriculture and associated runoff are all potential causes of current humpback whale habitat degradation.

The Bering Sea, including portions of the MMS North Aleutian Basin Planning Area (which is currently under Presidential withdrawal from leasing), is an area of high use by humpback whales for feeding during many months of the year. The MMS is considering whether to request amendment of the withdrawal to allow the North Aleutian Basin Planning Area to be included in the 2007-2012 5-Year Program. If oil and gas leasing and related activities occur, then humpback whales could be potentially impacted that same way as bowhead whales. Studies have documented that humpback whales, especially females with calves, respond to seismic survey noise and Todd et al. (1996) concluded that exposure of the humpbacks to deleterious levels of sound may influence entrapment rates.

Overall, the Proposed Action is likely to result in some incremental contribution to effects on humpback whales through the possible exclusion or avoidance from feeding or resting areas and possible disruption of important biological behaviors. These effects would be limited in scope due to the low level of humpback whale occurrence in the Proposed Action area.

V.C.6.b. Endangered and Threatened Birds.

The cumulative effects of the Proposed Action on threatened and endangered birds and designated critical habitat are evaluated in the Biological Evaluation prepared by the MMS to meet responsibilities under the ESA. The cumulative effects analysis is in a somewhat different format than the analyses presented in this NEPA document.

Cumulative effects to spectacled and Steller's eiders and Kittlitz's murrelets would be similar to those identified for similar marine and coastal bird species (Sec IV.C.1.f.(2)), except that the significance thresholds are different. The FWS BO concluded that 3 adult spectacled eiders and 1 adult Steller's eider may be incidentally taken through collisions with structures during activities authorized during leasing and exploration activities resulting from Lease Sale 193. If spectacled and Steller's eider populations continue to decline, any future losses would not be recovered within a generation and MMS would consider this take to be a significant impact.

There is no authorized incidental take associated with oil spills as they are considered an unlawful activity. If spectacled and Steller's eider populations continue to decline, any spectacled and Steller's eider mortality associated with an oil spill would be a significant impact.

V.C.7. Marine and Coastal Birds.

The cumulative effect of seismic exploration on marine and coastal birds probably would be minimal, particularly to birds staging or molting in the Ledyard Bay area. This conclusion is based on seismic vessel activity not being allowed in this area after July 1 of each year and aircraft are required to remain 1,500 ft above the area or use designated routes during poor weather. Exploratory drilling activity carries additional mitigation requirements (see Section II.B.3).

The cumulative effect of disturbance due to seafloor sampling and drilling platforms probably would be minor, due to displacement from surface areas, such as Ledyard Bay; regardless, the MMS would review further any installation proposals. The cumulative effect of exploratory discharges probably would lead to low effects in offshore locations. The discharge of produced water year round anywhere probably would lead to moderate effects as contaminants on the surface could impacts birds in the vicinity of the discharge sites. Discharges in

nearshore Arctic Ocean waters have not been approved by USEPA, but any discharge proposals would be reviewed in detail by MMS and USEPA. We assume an extensive system of pipelines for offshore developments would impact several hundreds of acres of bird molting and foraging habitat impacted during construction and this activity would be a major, but short-term impact that would result in the displacement of staging and molting birds from nearshore areas. Inspections, over time, could result in temporary displacement effects. The disturbance effects would be reviewed further by the MMS and the U.S. Army Corps of Engineers, but we also assume that the effects of an alternative to production pipelines—the transportation of produced oil in vessels—would be much worse. The OSRA model estimates that the mean number of large offshore spills $\geq 1,000$ bbl during the production life of the fields would be 0.96 (Table V-1). If oil from such spills contacted the Chukchi Sea coastline, the oil probably would persist in the tidal and subtidal sediments for a couple decades, leading to a significant long-term impact to marine and coastal birds and their nearshore habitats either directly important or immediately adjacent to areas to tens of thousands of birds during critical lifestages such as migration, nesting, molting, and brood-rearing. During the abandonment phase, we assume that the offshore pipelines would be cleaned, plugged, and abandoned in place. For purposes of analysis, one large spill was assumed to occur and is analyzed in this EIS. Overall, the cumulative level of effect on marine and coastal birds would be significant in most cases. A large oil spill would likely impact marine and coastal birds and their habitats for decades and could result in the loss of discrete breeding populations of several species along Chukchi Sea coast.

Subsistence hunting, coastwise and maritime traffic, and any discharges from local communities have the potential for local impacts on marine and coastal birds. The environmental changes associated with Arctic climate change have the potential to impact marine and coastal birds in the Chukchi Sea region.

V.C.8. Other Marine Mammals.

Considering ongoing assessments of climate change (Sec. III.A.2), this discussion of cumulative impacts will focus primarily on the effects of climate change. We identify ringed seals and other ice-dependent pinnipeds as being particularly vulnerable to the impacts of continued climate change and, therefore, conclude that the potential cumulative effects on them are a primary concern and warrant continued close attention and effective mitigation practices.

Oil and gas activities, increasing concentrations of contaminants in the Arctic, and large volume fish removals in the Bering Sea also may be affecting marine mammal populations (Quakenbush and Sheffield, 2006). Marine mammals also face increased industrial development and increased human activity in the Arctic, which likely will interact synergistically in a cumulative fashion. Beluga, walrus and seal populations that occur in the Chukchi Sea all migrate to the Bering Sea where there is a large amount of human activity. Further, they also migrate past the Red Dog Mine port site. That site may also become the port facility for a very large proposed coal mining operation adjacent to the Chukchi Sea.

The northern Alaska coal province contains the largest coal resource in the entire United States and ranks among the top coal-bearing formations occurring in the world (USDO, BLM, 1998b). These reserves are thought to represent 40% of total bituminous coal reserves remaining in the United States and about one-ninth of the world's reserves. High-quality coal is distributed from the Chukchi Sea coast east 300 mi through the NPR-A, although the high cost of transporting it to market has been a major barrier to its development (Dau, 2005). Alternatives are being considered, including transporting coal to the Red Dog Mine via road to provide a cheaper source of power than diesel. Another option would be to burn the coal at the deposit to generate electricity, which then would be carried to the Red Dog Mine via high-voltage power lines (Dau, 2005).

The MMS also looked at potential threats that contaminants may pose to marine mammals in the Arctic, particularly the Pacific walrus, which are an important subsistence resource in the Chukchi Sea region. Very little information has been published on the effects of contaminants on the Pacific walrus, and MMS is aware of no analysis of cumulative effects that has been published to date. The Pacific walrus is a long-lived species that feed primarily on benthic invertebrates, some of which are known to concentrate contaminants (Doroff and Bodkin, 1994). Pacific walruses also are an important food source for a number of coastal Alaskan villages (Egelund, Feyk, and Middaugh, 1998).

The most recent contaminants study of the Pacific walrus (*Odobenus rosmarus*) used samples collected in the Bering Sea in 1991. Seagers and Garlich-Miller (2001) analyzed levels of organochlorine compounds and

aliphatic hydrocarbons from 27 blubber samples. The authors compared their results with samples collected in 1981 through 1984 (Taylor, Schliebe, and Metsker, 1989) and with samples collected in 1972 (Galster and Burns, 1972). In the most recent study, dichloro-diphenyl-trichloroethane (DDT) and its metabolites, dichloro-diphenyl-dichloroethylene (DDE) and dichloro-diphenyl-dichloroethane (DDD), were not detected. Chlorinated hydrocarbons were also absent or below detection levels. Very low traces of Lindane and related isomers (range of 0.02-0.17) were detected. Very low but detectable amounts of Dieldrin, heptachlor epoxide and oxychlorane were found in most samples. Very low levels of PCB's also were detected in 19 samples. The authors concluded that concentrations of organochlorine pesticides were far below levels where contaminant-induced immunosuppressive effects have been shown to occur in pinnipeds elsewhere in the world. In addition, traces of aliphatic hydrocarbons were detected in all samples in concentrations below levels associated with recent exposure to petroleum pollutants.

Warburton and Seagers (1993) compared metal concentrations from 56 liver and kidney samples collected from 1986-1989 with 57 samples collected from 1981-1984 (Taylor, Schliebe, and Metsker, 1989). While still low, trace levels of selenium, arsenic and lead increased significantly between the two time periods. Selenium was the highest at 17.6 parts per million (ppm). Levels of cadmium and mercury did not increase; however, cadmium levels remained high (mean of 166.5 ppm). Unfortunately, there is no information to determine whether or not there are health effects for walrus at this cadmium level. Although human industrial activities can be significant point sources for cadmium, cadmium also occurs naturally throughout the environment. High cadmium levels may be naturally occurring in the environment of the Pacific walrus and not due to anthropogenic sources.

The State of Alaska Epidemiology Department has evaluated the most recent heavy metal and persistent organic chemical contaminant analyses with regard to the Pacific walrus. The department continues to recommend no restrictions on human consumption of walrus (Ponce et al, 1997; Egeland, Feyk, and Middaugh, 1998).

There is a high degree of uncertainty regarding the spatial scope of potential industry activities on the Alaskan OCS. However, the Proposed Action would increase the overall industry footprint and add to the amount of industry activity in the sale area.

V.C.8.a. Seismic Surveying.

Because very little is known about the distributions, population sizes or habitat use of marine mammals in the Chukchi Sea, it is difficult to determine if significant impacts will or will not occur to marine mammals as a result of the proposed action. However, no significant effects to nonendangered marine mammal population, as defined in Section IV.A.1, are expected to result from planned seismic activities. For a recent comprehensive overview of the effects of seismic activities on marine mammals, please see the seismic-survey Programmatic Environmental Assessment (PEA) (USDO, MMS, 2006a) (http://www.mms.gov/alaska/ref/EIS%20EA/DraftProgrammatic%20EA%20&%20Biological%20Eval/PEA_1.pdf).

V.C.8.b. Climate Change.

Sea ice is changing in thickness, persistence, and distribution (Sec. III.A.4, Sea Ice). As explained in Section III.A.4, analysis of long-term data sets indicate that substantial reductions in both the extent and thickness of the arctic sea-ice cover have occurred during the past 20-40 years, with record minimum extent in 2002 and again in 2005, and extreme minima in 2003 and 2004 (Stroeve et al., 2000; NASA, 2005). In Alaska and western Canada, winter temperatures have increased by as much as 3-4 °C (5.4-7.2 °F) over the last 50 years, and rain events have increased substantially across much of the Arctic (ACIA, 2004). Evidence indicates that oceanographic conditions have been changing in the Bering Sea (Sec. III.A.3, Oceanography), which suggests changes in the ecosystem may be occurring as well (Quakenbush and Sheffield, 2006).

Many authors have reported climate-change effects on marine mammals. For marine mammals adapted to life with sea ice, the effects of reductions in sea ice are likely to be reflected initially by shifts in range and abundance (Tynan and DeMaster, 1997), particularly for seals, gray whales, and walrus. This is due not only to the changing sea-ice habitat, but also to concurrent shifts in their prey distributions, such as fish, bivalves, and amphipods. Ice-associated pinnipeds, which rely on suitable ice substrate for resting, pupping, and molting, may be especially vulnerable to such changes. Indirect effects of climate change include regional or seasonal

shifts in prey availability, which can affect nutritional status, reproductive success, and geographic range, and alterations in the timing or patterns of migrations, which may produce changes in species distribution and stock structure. Changes in the extent and concentration of sea ice may alter the seasonal distributions, geographic ranges, patterns of migration, nutritional status, reproductive success, and ultimately the abundance and stock structure of some species, including beluga and gray whales. Alteration in the extent and productivity of ice-edge systems may also affect the density and distribution of important ice-associated prey of marine mammals, such as arctic cod and sympagic (“with ice”) amphipods” (Tynan and DeMaster, 1997).

In the past decade, geographic displacement of marine mammal-population distributions has coincided with a reduction in sea ice and an increase in air and ocean temperatures in the Bering Sea (Grebmeier et al., 2006). As a result, between 1981 and 2002, gray whales relocated their primary foraging area from the Chirikov Basin, adjacent to the north shore of St. Lawrence Island, northward into the Chukchi Sea (Moore, Grebmeier, and Davies, 2003). Similar displacements of key walrus foraging areas could result from recent population declines of bivalves, the primary prey item of walruses, in the Bering Sea (Lovvorn et al., 2003). Continued warming is likely to increase the occurrence and resident times of subarctic species (spotted seals, walruses, and beluga whales) in the Chukchi and Beaufort seas. Negative effects on truly arctic species (polar bears, ringed seals, and bearded seals) also are likely to result from climate warming. Polar bears and ringed seals depend on sea ice for their life functions, and continued reductions in the extent and persistence of ice in the Beaufort and Chukchi seas will almost certainly have negative effects on their populations (USDOI, FWS, 1995).

Climate change already has affected polar bears in Western Hudson Bay (WHB), where bears hunt ringed seals on the sea ice from November to July and spend the open-water season fasting on shore. In a long-term study, Stirling, Lunn, and Iacozza (1999) correlated decreased body condition and reproductive performance in bears with a trend toward earlier breakup of sea ice in recent years. The earlier breakup shortens the bears feeding season and increases the length of their fasting season. Ringed seals often give birth to and care for their pups on stable shorefast ice; therefore, changes in the extent and stability of shorefast ice or the timing of breakup could reduce their productivity. Because of the close predator-prey relationship between polar bears and ringed seals, decreases in ringed seal abundance can be expected to cause declines in polar bear populations (Stirling and Oritsland, 1995). In fact, a new analysis of the WHB polar bear subpopulation confirms that it has declined by almost 20% in the last 30 years (IUCN/PBSG Polar Bear Specialist Group, 2005), and that this decline is linked to significant reductions in the apparent survival of ringed seal pups coincident with earlier sea-ice breakup.

Climate change also has been implicated in the mortality of marine mammals. In early May 2005, a powerful storm blew more than 40 km for a 3-day period in the Bering Sea west of St. Lawrence Island. Because of the early breakup of the pack ice and reduced sea-ice cover, the ocean in the immediate vicinity of Gambell was nearly ice free, which allowed enough fetch for large waves to form, and forced migrating walrus herds to concentrate onto small icefloes. The large waves generated by the storm broke over all but the largest icefloes in the area. Local hunters indicated that the herds were negatively impacted by the severe weather. After the storm, hunters reported seeing only one or two calves among hundreds of females and harvesting many lactating females without calves. Walrus were so exhausted after the storm that they would not leave the ice when the hunters approached them, or even when animals on the same floe were harvested (USDOI, FWS, 2005b). This event has negative implications for future walrus recruitment and reproductive success. Similarly, Monnett and Gleason (2006) reported unprecedented polar bear mortalities following a severe storm event in the Beaufort Sea in the fall of 2004. They attributed this phenomenon to longer open-water periods and reduced sea-ice cover.

The main impacts of climate change on cetaceans would result from habitat changes (e.g., ice melting) that might impact prey migration, location, or availability as well as potentially impacting existing migratory routes and breeding or feeding grounds.

Because of the Arctic Ocean’s relatively low species diversity, it may be particularly vulnerable to trophic-level alternations caused by global warming (Derocher, Lunn, and Stirling, 2004). For example, Mecklenburg et al. (2005) and others show that changes in the arctic ice cover are affecting arctic fish (Loeng, 2005). In Hudson Bay for instance, Gaston, Woo, and Hipfner (2003) concluded that the decline in arctic cod and increase in capelin and sand lance were associated with a general warming of the waters and a significant decline in the amount of ice cover. In fact, their evidence suggests that the fish community in northern Hudson Bay shifted from Arctic to Subarctic from 1997 onwards, which was reflected in dramatically altered diets of thick-billed

murres (*Uria lomvia*) in the region. Likewise, fish assemblages and populations in Alaska have undergone observable shifts in diversity and abundance during the last 20-30 years. Changes in distributions of important prey species, such as arctic cod, could have cascading effects throughout the ecosystem.

The arctic cod is a pivotal species in the arctic food web, as evidenced by its importance as a prey item to belugas, narwhals, ringed seals, and bearded seals (Davis, Finley, and Richardson, 1980). In arctic regions, no other prey items compare with arctic cod in abundance and energetic value. Arctic cod are believed to be adapted to feeding under ice and ice-edge habitat is critical to cod recruitment (Tynan and DeMaster, 1997). Indeed, hydroacoustic surveys of fish have recorded the highest densities immediately below landfast sea ice (Crawford and Jorgenson, 1990). Because the life history of arctic cod is closely linked to sea ice, regional changes in the extent of sea ice may lead to a redistribution of this key prey species, and consequently to redistributions and altered migrational patterns of the marine mammals that feed on it, such as belugas, ringed seals, and spotted seals. For example, belugas are known to forage at ice edges and ice cracks (Bradstreet, 1982; Crawford and Jorgenson, 1990), presumably to feed on arctic cod, and beluga feeding aggregations primarily occur in nearshore areas, where dense schools of arctic cod concentrate in late summer. As a result, the IWC considers all stocks of beluga whale to be particularly vulnerable to arctic climate change.

Reduction in the extent of the ice edge and its associated biota may have deleterious consequences for marine mammals that have evolved with these unique systems (Tynan and DeMaster, 1997). For example, there is a linkage between ice algal production and benthic communities. Ungrazed ice algae that settle to the bottom provide a flux of carbon to the benthic community on which many marine mammals depend (Tynan and DeMaster, 1997). This sedimentation of carbon on shallow arctic shelves is critical to the benthic foraging success of walruses, bearded seals, and gray whales, and regional changes in this carbon flux could affect the distribution and reproductive success of these animals. In addition, the juxtaposition of the ice edge with shallow-shelf habitat suitable for benthic feeding is critical to walruses and bearded seals.

Species such as walrus and bearded seals feed on benthic prey, and are therefore found on ice cover over shallow continental shelf areas (Derocher, Lunn, and Stirling, 2004). Arctic warming may move the summer position of the ice edge over deep water unsuitable for these shallow water adapted species; the effects of such changes on their populations could be substantial (Tynan and DeMaster, 1997). As sea ice declines, these species are forced further offshore to find suitable habitat for feeding and pupping, making these activities more difficult if not impossible, which may ultimately lead to a net reduction in their abundance (ACIA, 2004; Derocher, Lunn, and Stirling, 2004). Recent trends have resulted in seasonal sea-ice retreating off the continental shelf and over deep Arctic Ocean waters. This trend poses adaptive challenges for the walrus population (Tynan and DeMaster, 1997). For example, in the summer of 2004, nine motherless walrus calves were observed stranded on icefloes in deep waters off of northwest Alaska. These calves may have been abandoned by their mothers due to lack of food, and the authors speculate that many more motherless calves than the nine observed were present in their study area. Walrus calves are dependent on maternal care for 2 years or more before they are able to forage for themselves and females with calves are not normally observed in deep Arctic basin waters due to the lack of food and depth limits to their diving. Thus, such events could have negative implications for the Pacific walrus population if they become more common (Cooper et al., 2006).

Phocid seals also may be particularly vulnerable to habitat loss from changes in the extent or concentration of Arctic ice, because they depend on pack-ice habitat for pupping, foraging, molting, and resting (Tynan and DeMaster, 1997; ACIA, 2004; Derocher, Lunn, and Stirling et al., 2004). The ringed seal, a species intricately entwined with the sea ice, likely would be among the first marine mammals to show the negative effects of climatic warming (Ferguson, Stirling, and McLoughlin, 2005). This species depends on the stability of ice for the successful rearing of its young (Burns, Shapiro, and Fay, 1981), and arctic warming likely would reduce its abundance and distribution. In the eastern Beaufort Sea, Harwood, Smith, and Melling, (2000) found that early breakup of the ringed seals' landfast-ice breeding habitat had significant negative impacts on growth, condition, and survival of nursing pups. Although earlier spring breakup and an increased open-water season initially may benefit growth and reproduction of seals and, hence, recruitment, a continued trend toward earlier breakup eventually could be detrimental to ringed seals (Ferguson, Stirling, and McLoughlin, 2005). For example, young seal pups that are forced into open water at an early age may be exposed to increased risks of predation and thermal challenges (Smith and Harwood, 2001). Swimming exacts a high energy cost from pups (Smith, Hammill, and Taubol, 1991), and they require access to ice for resting after they have molted and weaned (Smith, 1987).

Unseasonal warming and unusual rainfall events due to climate change both have been implicated in lower ringed seal reproduction and pup survival (Smith and Stirling, 1975; Hammill and Smith, 1991; Stirling and Smith, 2004). In WHB, spring breakup has occurred earlier each year over the past 30 years (Ferguson, Stirling, and McLoughlin, 2005) and decreased snow depth, particularly below 32 centimeters, has corresponded with a significant decrease in ringed seal recruitment there. Pups in subnivean birth or haulout lairs with thin snow roofs are more vulnerable to predators than those in lairs with thick roofs (Smith and Stirling, 1975; Hammill and Smith, 1991; Furgal, Innes, and Kovacs, 1996), as well as to death by exposure and hypothermia due to den collapse (Smith, Hammill, and Taugbol, 1991). For example, during a mild period with some rain in Canada in 1979, hunting success of polar bears was three times greater than previously recorded in the high Arctic, largely because many ringed seal-pup lairs melted open, exposing them to predation (Hammill and Smith, 1991; Stirling and Smith, 2004). Researchers suspected that most of the pups in the affected area eventually were killed by polar bears, arctic foxes, and possibly gulls. Earlier spring breakup of sea ice together with snow trends suggest continued low pup survival in WHB (Ferguson, Stirling, and McLoughlin, 2005). If early-season rains become regular and widespread in the future, the mortality of ringed seal pups will increase, and populations may be significantly reduced, which likely also would produce negative effects on the reproduction and survival of polar bears (Stirling, 2002; Stirling and Smith, 2004; IUCN/PBSG Polar Bear Specialist Group, 2005).

In contrast, gray whales may benefit from arctic climate change. For example, sightings data of gray whale calves suggest that higher calf counts in the spring are associated with years of delayed onset of freezeup in the Chukchi Sea. During years of earlier freezeup, pregnant females must leave their feeding grounds sooner, having less time to nourish the developing fetus and store the fat necessary to support lactation during their stay in Mexican waters and long migration back to Alaska. Therefore, a warmer Arctic may be beneficial to gray whales (Tynan and DeMaster, 1997).

However, the relationship between the expanding gray whale population to amphipod community dynamics is unknown but is of considerable interest. In 1992, Highsmith and Coyle (1992) described how amphipod crustaceans dominated the benthic community in vast areas of the northern Bering Sea, and described them as one of the “most productive benthic communities in the world.” However, during the late 1980’s, the abundance and biomass of the amphipod community experienced a 30% decline in production. High-latitude amphipod populations are characterized by low fecundity and long generation times. Large, long-lived individuals are responsible for the majority of amphipod secondary production. Thus, a substantial reduction in the density of large individuals in the population will result in a significant, long-term decrease in production (Highsmith and Coyle, 1992). Such a trend could occur if, for example, the gray whale population reached its carrying capacity and began to “overgraze” its own habitat. If whale predation reached the point where amphipod populations declined, the amphipods would be slow to recover because of their low fecundity and long generation times. Such a long-term alteration in food webs and energy flow through the ecosystem could alter the ecosystem structure, leading to colonization by other benthic species, further impeding amphipod recovery (Highsmith and Coyle, 1992). This could force gray whales to extend their foraging activities into new regions or habitats, which seems to be what is happening.

In 2005, researchers tagged 17 adult gray whales with satellite-monitored radio tags (Mate and Urban-Ramirez, 2006). Of six whales tracked for longer than 100 days, all spent most of their time in the Chukchi Sea:

The most favored area during the feeding season was NNW of Bering Straits in the Chukchi, where three whales spent August through mid-November in roughly the same area before simultaneously heading south...Historically, gray whales have fed extensively over the shallow eastern Bering Sea shelf with only an estimated 10-15% of the population traveling into the Chukchi and Beaufort Seas.

Therefore, extensive use of the high-latitude regions of the Chukchi Sea appears to be a recent phenomenon and likely reflects changes in available food for gray whales in their traditional feeding areas. “This is likely the result of both top-down predation pressure from the recovered eastern gray whale population’s increased foraging requirements and bottom-up pressure as the growth of benthic amphipod species has been stifled by a recent Bering Sea regime shift” (Mate and Urban-Ramirez, 2006).

Conclusion. Due to the ongoing effects of climate change in the Arctic, continued close attention and effective mitigation practices with respect to nonendangered marine mammals populations and distributions are

warranted, particularly with respect to ringed seals, which will likely be among the first marine mammals to show the negative effects of climatic warming.

V.C.8.c. Polar Bear.

The main effects of concern to polar bears are climate change, overharvest, and oil and fuel spills. Considering ongoing assessments of climate change in the Arctic (Sec. III.A.2), we conclude that the potential effects of climate change on polar bears are a primary concern, and warrant continued close attention and effective mitigation practices. Polar bears also face increased industrial development and increased human activity in the Arctic, which will likely interact synergistically in a cumulative fashion. Quantitative data are lacking that specifically addresses the potential cumulative impacts of development on polar bears and the effects of disturbance related to human activities on polar bear habitat use, as well as recruitment and survival (Perham, 2005). There also is a high degree of uncertainty regarding the spatial scope of potential Industry activities on the Alaskan OCS. However, the proposed activities would increase the overall industry footprint and add to the amount of industry activity in the sale area.

V.C.8.c(1) Human Harvest of Polar Bears. Because the polar bear is a classic *K*-selected species, populations pushed below their level of maximum sustained yield can become unstable due to stochastic environmental processes and require a long recovery time; thus they are particularly vulnerable to overharvest (Amstrup, 2000). Sport hunting for polar bears has been banned in Alaska since 1972, although bears still are taken for subsistence, recreation, and handicrafts by Alaska Natives. In 1988, the Inuvialuit Game Council from Canada and the NSB from Alaska implemented the Polar Bear Management Agreement for the Southern Beaufort Sea, a voluntary agreement that limited the total harvest from the southern Beaufort Sea (SBS) population to within sustainable levels (Brower et al., 2002). The stipulations contained in this voluntary agreement are actually more stringent than those contained in the MMPA. Sustainable quotas under the agreement are currently set at 80 bears per year, of which no more than 27 may be female. This quota is believed to be at or near sustainable levels. Recent harvest levels (2000-2005) from the SBS stock averaged 37 individuals in the U.S. and 25 individuals in Canada, for an average harvest of 62 bears per year, well within the agreement's quotas (USDOI, FWS, unpublished data). However, recent information suggests that the SBS population may be smaller than previously estimated, which would indicate that current harvest levels may no longer be appropriate (Sec. III.B.6). For the same period, reported U.S. harvest levels of the Chukchi-Bering Sea (CBS) stock averaged 41 bears, while average Russian harvests of the CBS stock are believed to be much higher (Ovsyanikov, 2003; USDOI, FWS, 2003; USDOI, FWS, unpublished data).

A reliable estimate for the CBS stock of polar bears, which ranges into the southern Beaufort Sea, does not exist, and its current status is in question. In 2002, the IUCN/SSG Polar Bear Specialist Group estimated the size of the CBS population at 2000+ bears, though the certainty of this estimate was considered poor (Lunn, Schliebe, and Born, 2002). Russia prohibited polar bear hunting in 1956 in response to perceived population declines; however, both sport and subsistence harvest continued in Alaska until 1972. During the 1960's, hunters took an average of 189 bears per year from the CBS population, an unsustainable rate of harvest that likely caused significant population declines. With the passage of the MMPA in 1972, which prohibited sport hunting of marine mammals, the average annual Alaska harvest in the Chukchi Sea dropped to 67 bears per year. However, with the collapse of the Soviet empire in 1991, levels of illegal harvest dramatically increased in Chukotka in the Russian Far East (Amstrup, 2000; USDOI, FWS, 2003). While the magnitude of the Russian harvest from the CBS is not precisely known, some estimates place it as high as 400 bears per year, although the figure is more likely between 100 and 250 bears per year. Models run by the FWS indicate that this level of harvest of the CBS population is most likely unsustainable, and that an average annual harvest of 180 bears (4.5% of the starting population) potentially could reduce the population by 50% within 18 years (USDOI, FWS, 2003). This simulated harvest level is similar to the estimated U.S./Russia annual harvest for the period 1992-2006, as well as to the unsustainable harvest levels experienced in Alaska in the 1960's, indicating that the CBS stock of polar bears may well be in decline due to over harvest. The FWS calculations were based on a starting population of 4,000 bears, which is believed to fairly characterize a healthy CBS population. However, because of the unknown rate of illegal take currently taking place, in 2006, the IUCN/SSG Polar Bear Specialist Group (PBSG) designated the status of the CBS stock as "declining" from its previous estimate of 2000+ animals (IUCN/SSG Polar Bear Specialist Group, 2006). Therefore, the current levels of illegal harvest of the CBS polar bear stock, in conjunction with climate change effects, probably are the greatest current threats to this population.

V.C.8.c(2) Oil and Fuel Spills. Offshore oil development represents a large proportion of reasonably foreseeable future development in the Arctic. In Canada, oil and gas developments in the Mackenzie River Delta and in the Beaufort Sea would extend oil and gas development along virtually the entire Beaufort Sea coast occupied by the Southern Beaufort Sea polar bear population. Devon Canada Exploration has identified nine offshore drilling targets within the landfast ice zone of the southern Beaufort Sea. According to Canadian law, Devon must drill at least one well in each of four areas by the end of the license period in 2009, or lose their license to the area. As a result, Devon plans to drill one well per winter through 2009 (Devon Canada Corporation, 2004).

In addition to potential oil spills from industry infrastructure, as outlined in Section IV.C.1.d(2), the potential also exists for oil/fuel spills to occur from associated support vessels, fuel barges, and even aircraft. However, this risk is considered slight in ice-free waters, and any spills which result from the proposed action will most likely be of small volume, and are not considered a major threat to marine mammals in the action area. Impacts to them would most likely include temporary displacement until clean-up activities are completed. The potential impacts of a larger spill are similar to those discussed in Section IV.C.1.d(2).

Oil spills from offshore production activities are of concern because as additional offshore oil exploration and production, such as the Liberty, Ooguruk, and Nikaitchuq projects, occurs, the potential for large spills in the marine environment increases.

A description of the potential effects of an oil spill on polar bears in the Southern Beaufort Sea can be found in the Sale 202 EA (USDOI, MMS, 2006e).

V.C.8.c(3) Climate Change. According to the FWS, the status of polar bears worldwide is declining as a result of climate changes, loss of ice habitat, and unregulated hunting pressures (USDOI, FWS, 2005b). The recent release of the Arctic Climate Impact Assessment's report on *Impacts of a Warming Arctic* (ACIA, 2004), combined with a peer-reviewed analysis of the effects of climate change on polar bears by three of the world's foremost polar bear experts (Derocher, Lunn, and Stirling, 2004) indicate that polar bears are facing a cascading array of effects as a result of dramatic changes to their habitat. Observed changes to date include reduced sea-ice extent, particularly in summer (Sec. III.A.4), and progressively earlier sea-ice breakup dates, especially in more southerly areas. Bears at the southern edge of the species' range already are showing the impacts of these changes. Breakup of the annual ice in WHB in Canada is now occurring more than 2 weeks earlier than it did 30 years ago (Stirling, Lunn, and Iacozza, 1999; Stirling et al., 2004), which is causing declining reproductive rates, subadult survival, and body mass in polar bears there. There is a highly significant correlation between this earlier breakup of the sea ice and condition of bears when they come to shore (Derocher, Lunn, and Stirling, 2004) that, in turn, is correlated with their reproductive success. Stirling, Lunn, and Iacozza (1999) correlated decreased body condition and reproductive performance in WHB bears with the trend toward earlier sea ice breakup, which shortens their feeding season and increases the length of their fasting season. Stirling, Lunn, and Iacozza (1999) also reported a significant decline in the body condition of both male and female adult polar bears in WHB, as well as a statistically significant relationship between the date of sea-ice breakup and the condition of adult female polar bears and natality. The earlier the breakup, the poorer the condition of females coming onshore, and the lower their natality level. Because body mass in adult females is correlated with reproductive success, females with lower fat stores likely will produce more single-cub litters, fewer cubs overall, and smaller cubs with lower survival rates (Derocher, Lunn, and Stirling, 2004). Poor hunting conditions in the early spring could also lead to increased cub mortality (Derocher, Lunn, and Stirling, 2004).

This is directly related to the effects of the sea-ice condition on ringed seals. For example, ringed seals often give birth to and care for their pups on stable, shorefast ice; therefore, changes in the extent and stability of shorefast ice or the timing of breakup could reduce their productivity. Because of the close predator-prey relationship between polar bears and ringed seals, decreases in ringed seal abundance can be expected to cause declines in polar bear populations (Stirling and Oritsland, 1995). In fact, a new analysis of the WHB subpopulation confirms that it has declined by almost 20% in the last 30 years (IUCN Polar Bear Specialist Group, 2005), and that this decline is linked to significant reductions in the apparent survival of ringed seal pups coincident with larger amounts of open water earlier in the summer. Similar impacts also may be occurring in other polar bear populations but have either not yet been documented or have not yet been published.

Derocher, Lunn, and Stirling (2004) predict that adverse demographic effects from climate change will first be manifest as lowered female reproductive rates and juvenile survival rates. Adult female survival rates likely

will be affected only under more severe conditions. In spring 2006, USGS researchers observed three adult female polar bears (2 with radio collars and 1 without) dead along Alaska's Beaufort Sea coast. A third collared adult female "disappeared from the airwaves," but her yearling cub (1 of 3) subsequently was found dead in a starved condition. Field necropsy confirmed two of the three adult females died of starvation. The cause of death of the third was undetermined, due to the degree of scavenging of the carcass. Because only 14% of yearling polar bears accompanied by their mothers fail to survive until weaning (Amstrup and Durner, 1995), there is an 86% probability that the collared mother of the emaciated yearling also died. Radio-collared females previously have not been found dead of apparent starvation and overall, these observations are unprecedented in the 25 years that polar bears have been radio-collared in Alaska (Amstrup, 2006, pers. commun.).

Climate change also may explain why coastal communities in WHB and other areas recently have experienced increased bear-human conflicts prior to freezeup each fall. It has been suggested that sea-ice availability and the amount of time that bears are forced on land may be an important variable in the amount of bear-human interactions which occur (Clark, 2003). With earlier sea-ice breakup, polar bears are forced ashore earlier, in poorer nutritional condition, and remain without access to seals for a longer time. As they exhaust their fat reserves towards the end of the ice-free period, they are more likely to encroach on human settlements in search of alternative food sources and come into conflict with humans. Starving bears are particularly dangerous, because they will risk death in an attempt to obtain food. For example, recent events in Russia indicate that many bears have been congregating outside of northern villages during the fall open-water season, and several people have been killed by polar bears there in recent years (Johnson, 2006, pers. commun.). Similarly, in October 2004, a very young polar bear in "poor" condition was killed by homesteaders in what was described as a "predatory" interaction at the mouth of the Colville River on Alaska's North Slope (USDOL, FWS, unpublished data). As a result of such increased bear-human interactions, defense kills of bears increase during periods of low food availability. For example, in the eastern Beaufort Sea in spring 1974, seal populations were greatly reduced. Researchers predicted that subadults would be in poorer condition, interact more with humans, and suffer a higher death rate in the winter of 1974. These predictions were subsequently borne out. Once seal populations recovered, defense kills dropped from a high of seven bears killed per winter back down to the average of two. Thus, the increase in polar bear-human interactions in WHB and other areas probably reflect an increase in nutritionally stressed bears searching for food (Amstrup et al., 2006). If climate change continues, more such events can be expected to occur in Alaska. In the absence of ice, the majority of bears will move to land during the open-water period and be distributed on the islands and the coast of Alaska and Chukotka (Kochnev, In prep).

Polar bear use of coastal areas during the fall open-water period has, in fact, increased in recent years in the Beaufort and Chukchi seas (Sec. IV.C.1.h). This change in distribution has been correlated with the distance to the pack ice at that time of year (i.e., the further from shore the leading edge of the pack ice is, the more bears are observed onshore) (Kochnev et al., 2003; Ovsyanikov, 2003; Schliebe et al., 2005; Kochnev, In prep.).

Climate change has also affected the severity of autumn storm events as a result of reduced sea-ice cover. In 2001 rough weather prevented scouting about one-third of the time that whaling crews were on Cross Island (Galginaitis and Funk, 2004:24) and about half of the time during 2003 (Galginaitis and Funk, 2005:18). The unusually rough water that restricted the scouting for whales might have been related to changes in the summer ice cover during recent years. As explained in Section III.A.4, analysis of long-term data sets indicate that substantial reductions in both the extent and thickness of the arctic sea-ice cover have occurred during the past 20-40 years, with record minimum extent in 2002 and again in 2005, and extreme minima in 2003 and 2004 (Stroeve et al., 2005; NASA, 2005).

As the distance between the southern edge of the pack ice and coastal areas increases, it will become increasingly difficult and more hazardous for pregnant bears to reach their denning areas (Derocher, Lunn, and Stirling, 2004). Polar bears also are likely to face increased energetic costs as a result of less ice and more open water. When the ice cover is reduced, particularly during late summer, the available open-water surface area increases, and waves are able to grow in height. Typical wave heights are up to 1.5 m during summer and up to 2.5 m during fall. Expected maximum wave heights are 7-7.5 m in the Beaufort Sea (Brower et al., 1988), and a late-summer storm in the Beaufort in September 2000 developed waves 6-7 m high at Point Barrow (Lynch et al., 2003). Such large waves undoubtedly would induce energetic stress, or worse, in any swimming bears unfortunate enough to be caught in them. Despite being strong swimmers, energetically stressed bears are susceptible to misfortune on long-distance swims. For example, Monnett and Gleason (2006) reported unprecedented polar bear mortalities following a severe storm event in the Beaufort Sea in fall 2004. They

estimated that at least 27 bears may have died as a result of this one storm, and they attributed the phenomenon to longer open-water periods and reduced sea-ice cover.

The increased temporal and spatial extent of late summer and early autumn open water in northern Alaska also has led to the dramatic erosion of coastal shorelines and bluff habitats, which often are preferred den sites for maternal polar bears (Durner, Amstrup, and Ambrosius, 2006). Polar bear terrestrial denning likely will become more important in the near future. The southern Beaufort Sea polar bear population is unique in that approximately 50% of its maternal dens occur annually on the pack ice (Amstrup and Garner, 1994), which requires a high level of sea-ice stability for successful denning. Reproductive failure is known to occur in polar bears that den on unstable ice (Lentfer, 1975; Amstrup and Garner, 1994). If climate change continues to decrease sea ice in the Arctic, and increases the amount of unstable ice, a greater proportion of polar bears may seek to den on land (Durner, Amstrup, and Ambrosius, 2006). Those that do not may experience increased reproductive failure, which would have population-level effects. Considering that 65% of confirmed terrestrial dens found in Alaska from 1981-2005 were on coastal or island bluffs, the loss of such habitats, through storm-surge erosion, likely would alter future denning distributions (Durner, Amstrup, and Ambrosius, 2006) that, in turn, could affect reproductive success.

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

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

Projected impacts to polar bears from climate change would affect virtually every aspect of the species' existence. The timing of ice formation and breakup will determine how long and how efficiently polar bears can hunt seals. Reductions in sea ice will result in increased distances between the ice edge and land; this, in turn, will lead to increasing numbers of bears coming ashore during the open-water period, or drowning in the attempt. Reductions in sea ice also would increase the polar bears' energetic costs of traveling, as moving through fragmented sea ice and open water is more energy intensive than walking across consolidated sea ice. Reductions in sea ice may result in reduced availability of ringed seals, and will result in direct mortalities of bears from starvation. Continued climate change also likely will increase the occurrence of bear-human interactions on land. Furthermore, in 2006, the SBS population was estimated at ~1,526 individuals (Regehr et al., 2006), down from previous estimates of ~1,800 animals (Lunn et al., 2002). All of these factors are likely to result in impacts to polar bear populations and distribution, similar to what has already been documented in more southerly areas, such as WHB. As stated by Regehr et al. (2006):

The relationship between decreased availability of sea ice and declining population size in western Hudson Bay, which is near the southern extreme of polar bear range, is cause for concern regarding the future status of polar bears in more northern regions such as the SBS. Because more profound declines in sea ice area and extent are predicted for these northern regions, continued monitoring and conservative management of the SBS polar bear population is warranted.

V.C.8.c(4) Increased Shipping. Ships using the newly opened waters in the Arctic likely will use leads and polynas to avoid icebreaking and to reduce transit time (USDOJ, FWS, 1995). Leads and polynas are critical

habitat for polar bears, especially during winter and spring, and heavy shipping traffic could disturb polar bears during these critical times (USDOI, FWS, 1995).

Conclusion. Due to the ongoing effects of climate change in the Arctic, and because of the observed and predicted impacts that climate change can have on polar bears, continued close attention and effective mitigation practices, such as those identified in Section IV.C.1(h)5, with respect to polar bears are warranted.

V.C.9. Terrestrial Mammals.

A number of large-scale developments are being considered for northwest Alaska. Potential impacts of individual projects on terrestrial animals should not be evaluated in isolation. Instead, the cumulative effects of all existing and proposed development should be considered collectively over the short and long term to predict impacts on animals (Dau, 2005). Because no large-scale, long-term monitoring system has been established on the North Slope, information gaps make it hard to assess the full extent of cumulative effects.

A major concern regarding land management in the western Arctic is that the same pattern of incremental, piecemeal development that has occurred in the central Arctic will be repeated as industry moves westward. In the absence of a comprehensive conservation strategy, expanding industrial development over the next 25-50 years may have significant impacts on individual animal populations, subsistence use opportunities, and the integrity of the greater ecosystem (Schoen and Senner, 2003).

The Western Arctic Caribou herd (WAH) can be considered a “keystone” population, in that it provides critical resources for many other species sharing the ecosystem and is an important subsistence resource for as many as 40 Native villages within the herd’s annual range (Schoen and Senner, 2003). Therefore, careful consideration must be given to the impact of potential developments to this herd as well as the Teshekpuk Lake Caribou Herd (TCH).

Some Alaskan 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). Some Natives from Kaktovik have noticed that caribou overwintering on the North Slope have become scarce since development of the oil fields (Rexford, 1982). Recent studies (Roby, 1978; Cameron, Whitten, and Smith, 1981, 1983; Cameron et al., 1992; Pollard and Ballard, 1993; Joly, Nellemann, and Vistness, 2006) indicate significant seasonal avoidance of habitat near (within 4 km [2.4 mi]) some existing Prudhoe Bay area facilities by cows and calves during calving and early postcalving periods (May through June). For example, abundance of calving caribou in the Milne Point area declined significantly with progressive development (Noel, Parker, and Cronin, 2004; Joly, Nellemann, and Vistness, 2006). In the Milne Point area, Joly, Nellemann, and Vistness (2006) found that there has been a gradual abandonment of developed areas of the oilfield during calving and a drop in abundance of calving caribou by at least 72% within the oilfield, despite the fact that the CAH herd size has increased 4- to 5-fold during the same period (1978-2000). Since 1987, there has been a southward shift of the calving ground away from the oilfield study area. This has been attributed to the development of roads and pads in the calving grounds, which placed 92% of the study area within 4 km of the developments. The remaining undisturbed fragments were too small for continued use for concentrated calving (Joly, Nellemann, and Vistness, 2006). Proportionately, in relation to a herd that increased 4- to 5-fold, the decline is much larger (Joly, Nellemann, and Vistness, 2006).

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 of the caribou’s summer range. However, caribou abundance and overall distribution have not been affected, and the CAH 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 7 ft above the tundra, a requirement for onshore pipelines in the NPR-A (USDOI, BLM, 2006). Pipelines without adjacent roads and vehicle traffic are not likely to affect caribou movements.

These findings suggest that caribou are able to habituate and adapt to oilfield infrastructure, and that significant impacts to caribou herds on the North Slope as a result of the proposed action are not likely.

Some known potential projects that could affect terrestrial mammals include:

1. Oil and gas development NPR-A south. Roughly 80% of the WAH calving grounds are located in this area, which also contains important insect relief habitat (Dau, 2005). The area south and east of Teshekpuk Lake is the primary calving ground for the Teshekpuk Caribou Herd (Schoen and Senner, 2003). The highest potential oil resources of the Northwest Planning Area are in its northeast corner between Smith Bay and Dease Inlet (USDOI, BLM, 2005).

2. Coal development-Brooks Range. The northern Alaska coal province contains the largest coal resource in the entire United States and ranks among the top coal-bearing formations occurring in the world (USDOI, BLM, 1998b). These reserves are thought to represent 40% of total bituminous coal reserves remaining in the United States and about one-ninth of the world's reserves. High-quality coal is distributed from the Chukchi Sea coast east 300 mi through the NPR-A.

Coal underlies virtually the entire WAH calving grounds, although the high cost of transporting it to market has been a major barrier to its development (Dau, 2005). Alternatives are being considered, including transporting coal to the Red Dog Mine via road to provide a cheaper source of power than diesel. Another option would be to burn the coal at the deposit to generate electricity, which then would be carried to the Red Dog Mine via high-voltage power lines (Dau, 2005).

3. Expansion of Red Dog Mine. The world's largest known zinc resources are located in the western Brooks Range. As much as 25 million tons of high-grade zinc is estimated to reside near Red Dog Mine, approximately 40 mi from the southwest corner of the NPR-A (Schoen and Senner, 2003).

4. Road Construction. Constructing a road linking Red Dog and Noatak to reduce the cost of transporting fuel to this community and to allow workers to commute between Noatak and Red Dog Mine.

5. Development of bornite mining in the Ambler Mining District. Nova Gold is assessing the feasibility of mining in this area. One option being considered for transporting ore is a future road from the Dalton Highway to the Red Dog Mine road (Dau, 2005).

Conclusion: The above activities have the potential to affect terrestrial mammals of the North Slope. Subsistence take, recreational hunting, and the environmental changes associated with Arctic climate change have the potential to impact terrestrial mammals to varying degrees.

V.C.10. Vegetation and Wetlands.

This cumulative analysis considers the effects of impact-producing factors related to the Proposed Action; prior and future OCS sales; State and private oil and gas activities; other government and private projects and activities; and pertinent natural processes and events that may occur and adversely affect wetlands around Chukchi Sea Proposed Action area.

The scenario for new petroleum development in the Chukchi Sea was postulated in view of the existing infrastructure on the North Slope, because it is likely that future projects in northern Alaska will be tied into these facilities. The pipeline system to TAPS is assumed to carry oil production from the Chukchi, which could begin in 2020 (Table V-5). Peak oil production rate from the first offshore field is assumed to be approximately 225,000 bbl per day, which would constitute a 25% increase to the current rate through TAPS. This increase would require upgrading the pipeline and pump stations from their current condition because many of the pump stations have been idled. There is no infrastructure in NPR-A at the present time, so a new large-diameter gathering line is assumed to be constructed from the Chukchi coast to the Alpine Development area. The overland oil pipeline(s) would be elevated above ground and pump stations would be needed at about 100-mi intervals. The size and location of the overland pipeline(s) would be influenced by future discoveries and development in the Chukchi Sea and NPR-A, but it is logical to assume that they would be oriented west-east in the shortest corridor to any existing pipeline network such as that at Alpine.. Separation of associated-dissolved gas and produced water from the offshore field would be done on a central production platform to avoid bottlenecks in facilities near Prudhoe Bay. Natural gas would not be transported across NPR-A until a transportation system is constructed from the North Slope to Outside markets.

Impacts on vegetation caused by the proposed Sale 193 and other present and future oil activities could accumulate and persist, especially if the structures remain once industrial activity has ceased. A 2001 evaluation of cumulative impacts on the North Slope indicates that impacts on vegetation at present include approximately 7,011 ha (17,324 acres) of tundra and floodplains covered due to gravel road, gravel pads, and gravel mining (NRC, 2003b). Gravel roads and gravel pads represent more than 3,500 hectares (8,800 acres) and gravel mines nearly 2,600 hectares (6,400 acres) of the impacted area. The network of roads has grown incrementally as new fields have explored and brought into production. For a variety of reasons, nearly all roads, pads, pipelines, and other infrastructures are still in place and would continue into the future. Their effects would be manifested not only at the physical footprint itself, but also in the nearby vicinity. The indirect effects associated with existing roads, roadside flooding, dust-killed tundra, and thermokarst were estimated to cover at least 4,300 hectares (10,500 acres) (NRC, 2003b). Should production occur as a result of Sale 193, the majority of the existing infrastructure within NPR-A would be used with the exception of the possible construction of an overland pipeline to transport oil from the Chukchi Sea to the existing pipeline network to TAPS. Impacts associated with the possible construction of this pipeline would be additive to the existing infrastructure already in place on the North Slope.

Assuming that the pipeline would create an eastward corridor of about 100 ft wide and 300 mi long, the approximate area to be impacted would be approximately 1,470 hectares (3636 acres). This would represent a gross estimate of 35% increment from the area affected by the construction of the TAPS (4,144 hectares - 10,240 acres), but it represents <1% of the area covered by vegetation and wetlands of the North Slope. A pump station is foreseen to be constructed on gravel pads at about 100 mi from each other along the pipeline corridor, for a likely maximum of three to four pump stations. The burial of vegetation under gravel pads could be considered a permanent loss of the affected plant communities, as the potential recovery in gravel pads could take between 25 and 30 years or more (USDOI, BLM, 2004). The acreage of vegetation affected due to the construction of pump stations was not estimated. Rehabilitation of gravel pads can result in the growth of grasses-sedges within 2 years after abandonment of the pads, but the natural growth of plant cover on abandoned gravel pads would be very low. Construction of existing facilities, past exploration pads, and vehicle tracts across the tundra landscape have affected a small percentage of the total tundra and wetlands of the Arctic Coastal Plain; however, the local additive effects of gravel pads and roads, borrow sites, and other infrastructure would be expected to persist decades after the oil fields are abandoned.

Changes in vegetation resulting from dust and snowdrift accumulation or the formation and draining of impoundments, however, would not be considered permanent. Typically, permafrost-related geomorphic processes occurring in the North Slope create a constantly changing landscape that influences successional patterns in plant communities, so they are adapted to such frequent changes.

In terms of acres of land affected, construction of onshore infrastructure would cause more than 99% of the effects. Cumulative effects due to small oil spills and other discharges would be expected to be localized, with amounts averaging 3-5 gallons (gal) or less and would affect <50 (square feet [ft²]). Small spills occurring on snow are expected to have few cumulative effects, as they are usually cleaned up immediately upon discovery and usually are successfully removed before reaching the vegetation root mat.

Large oil spills ($\geq 1,000$ bbl) would have effects, especially if they take place during the growing season. The possibility of such a scenario is low, as most of the oil spills would cover <500 ft² (<0.01 acre). Other impacts would probably come from oil-spill-response training and cleanup. Trampling of vegetation and stockpiling or materials used during spill response activities may impact vegetation. Although the amount of the impact would depend on the size and location of the spill, in most cases, would be temporary. Plants would recover in 1 to several years except in those areas where the oil spill reaches the root mat, in which case, vegetation would be destroyed. However, the overall effects of spills have not accumulated on vegetation on Alaska's North Slope, because the spills have been small, and contaminant cleanup and rehabilitation efforts have generally been successful (NRC, 2003b).

Impacts to vegetation of Alaska's North Slope from oil and gas exploration and development in the Chukchi Sea are expected to be additive in nature with respect to the impacts (present and future) from other oil/gas and non-oil/gas activities outside the Proposed Action area. In other words, the acres affected within the Proposed Action area would increase to total acres affected on the North Slope by a proportional amount. As noted, this is expected to continue to be a fraction of the total North Slope acreage. It is not expected that synergistic

impacts to vegetation would occur by affecting additional acres, or would any effects (whether beneficial or countervailing) occur to vegetation as a result of additional acres developed.

The environmental changes associated with Arctic climate change have the greatest potential to impact vegetation and wetlands on the North Slope.

V.C.11. Economy.

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 NSB and revenues to the Federal, State, and NSB governments could decline. Fluctuations in oil prices and other factors generated fluctuations throughout the Alaskan economy from 1975-1995 (McDowell Group, Inc., 1999). The Alaskan economy is not nearly as dependent on the oil sector as it was in the mid-1980's, when the major crash in the Alaskan 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 TAPS 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, 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 pipelines, 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 that 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 193 described in Section IV.C.1.k; and (3) activities considered in cumulative-effects analysis described in Section V.B.

V.C.11.b. Cumulative Effects on State and Local Revenues.

The Northeast portion of the NPR-A alone would generate considerable revenues in the future. According to the final EIS for the Northeast NPR-A (USDOI, BLM, and MMS, 1998), oil from the Reserve at \$18 a barrel could generate additive annual revenues of \$28 million State and NSB share of royalty receipts, \$3 million property tax to the State, \$48 million severance tax to the State, and \$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.

The Northwest portion of the NPR-A also would generate considerable revenues in the future. According to the final EIS for the Northwest NPR-A (USDOI, BLM, and MMS, 2003), oil from the Reserve at \$18 at barrel could generate additive annual revenues equal to the Northeast portion.

Not counting the NPR-A, 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, and \$56 million Federal income tax.

In total, the cumulative case would generate the following additive annual revenues: \$32 million to the NSB and \$232 million to the State.

\$1.1 billion to the Federal Government would include additive jobs in petroleum exploration, development, and production, plus oil spill cleanup.

V.C.11.c. Cumulative Effects on Employment and Personal Income.

The cumulative gains in 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:

- 230 jobs annual average for NSB residents during development, declining to 50 during production. These include direct oil-industry employment, indirect and induced employment.
- \$16 million in total average annual personal income for workers residing in the NSB during development, declining to \$4 million during production.
- 8,000 jobs annual average during development, declining to 4,400 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.
- \$460 million in total average annual personal income for workers residing in Southcentral Alaska and Fairbanks during development, declining to \$250 million during production.
- 21,800 jobs annual average during development, declining to 11,300 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.
- \$1.11 billion in total average annual personal income for workers residing in the rest of the U.S. during development, declining to \$570 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 oil spills in the Chukchi Sea.

This information is derived from Section IV.C.1.k of this EIS; (USDOJ, MMS, 2003a:Sec. IV.C.10); and economic effects analysis in the draft EIS for the *Proposed Program Outer Continental Shelf Oil and Gas Leasing Program 2007-2012* (USDOJ, MMS, 2006c).

V.C.11.d. Cumulative Effects on Transportation.

In the event of a spill of 250,000 bbl of oil in the cumulative case in the Chukchi Sea, activities associated with cleaning it up would employ about the same number of workers as associated with the EVOS: 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. See the Liberty final EIS (USDOJ, MMS, 2002:Sec. IX.B.3.k) 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.11.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 NSB residents mainly by the loss of some part of those resources. See Section V.C.12 for effects on subsistence-harvest patterns.

Conclusions. The cumulative case would generate additive annual revenues, employment, and personal income increases. In total, the cumulative case would generate the following additive annual revenues: \$32 million to the NSB, \$232 million to the State, and \$1.1 billion to the Federal Government.

This cumulative case is projected to generate additive employment and personal income increases as follows:

- 230 jobs annual average for NSB residents during development, declining to 50 during production. These include direct oil industry employment, indirect and induced employment.
- \$16 million in total average annual personal income for workers residing in the NSB during development, declining to \$4 million during production.
- 8,000 jobs annual average during development, declining to 4,400 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.
- \$460 million in total average annual personal income for workers residing in Southcentral Alaska and Fairbanks during development, declining to \$250 million during production.
- 21,800 jobs annual average during development, declining to 11,300 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.
- \$1.11 billion in total average annual personal income for workers residing in the rest of the U.S. during development, declining to \$570 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 oil spills in the Chukchi Sea.

V.C.12. Subsistence-Harvest Patterns.

Cumulative effects on subsistence-harvest patterns include effects from Alternative I for Sale 193 exploration, development, and production and other past, present, and reasonably foreseeable projects in the Chukchi Sea region and on the North Slope (see Table V-7c). Alternative I for Sale 193 exploration, development, and production could affect subsistence resources because of potential oil spills; noise and traffic disturbance; or disturbance from construction activities associated with pipelines, landfalls, shore-base construction, and ice roads. Noise and traffic disturbance might come from building, installing, and operating production facilities and from supply efforts. See Section IV.C.1.m Effects on Subsistence-Harvest Patterns for a more detailed discussion of effects on subsistence resources and harvest patterns (USDOJ, MMS, 2003a).

To understand effects on subsistence-harvest patterns, we must recognize three major characteristics of Chukchi Sea coastal communities: (1) they rely heavily on bowhead and beluga whales, other sea mammals, caribou, and fish in the annual average harvest; (2) subsistence-hunting ranges overlap for many species harvested by these 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, walrus, bird, and caribou hunting in spring; and (c) whale, seal, bird, and caribou hunting during the open-water season (USDOJ, MMS, 2003a).

Oil and Gas Development in Federal, State, and Canadian Waters. In 2006, Pioneer Natural Resources Co. will begin the development of its North Slope Oooguruk field, which is in the shallow waters of the Beaufort Sea approximately 8 mi northwest of the Kuparuk River unit. Pioneer will begin construction in winter 2006 by installing an offshore gravel drilling and production site as soon as an ice road is completed, which will be used to haul gravel to the construction site. Some open-water activities in summer 2006 will involve placing armor (gravel bags) on the side-slopes of the constructed gravel island to protect it from erosion. In Canadian waters, Devon Canada Corporation is planning to do exploratory drilling off the Mackenzie River Delta in August 2006. The GX Technology Corporation will conduct a 2D seismic survey in the Mackenzie River Delta area in late summer and fall.

On the Chukchi Sea, west of the North Slope industrial complex and outside the southern boundary of the Proposed Action area, the major industrial developments have been and continue to be associated with Red Dog Mine and the Delong Mountain Terminal (DMT). These facilities are included in the cumulative activities scenario, because about 250 barge lightering trips per year are needed to transfer 1.5 million tons of concentrate to bulk cargo ships anchored 6 mi offshore. About 27 cargo ships are loaded each year. These activities have the potential to affect biological resources of concern (e.g., marine mammals and marine birds) that migrate just offshore of the facilities into the marine waters of the lease sale area. There is considerable local concern that noise and activity from construction and operation and the presence of new structures at the portsite might

frighten animals away or otherwise make them stay away so they could not be harvested or would be more difficult to harvest. There is also concern that project features might make travel to subsistence resources more difficult by directly blocking travel or by causing changes in the environment that would make travel more difficult, for example: concern that structures in the water might cause ice leads that would be difficult to cross (U.S. Army Corps of Engineers, 2005).

Direct effects include delay or deflection of resource populations' movements and mortality; indirect effects include destruction or degradation of habitat and changes in productivity. 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 significant effect because of potential long-term noise disturbance to migrating whales.

The disruption of bowhead whale harvests could result from any potential diversion of the whale migration further offshore, or from other behavior changes by the animals—making them more skittish, for example—in reaction to OCS activities. The greater the degree of activity onshore and on the OCS, as measured by increases in seismic noise, vessel traffic, east-to-west development, increased activity in the Chukchi Sea, Canadian activities in the Mackenzie Delta, or some other metric, the more probable and more pronounced cumulative effects are likely to be. To a large extent, stipulations, required mitigation, and conflict avoidance agreements between subsistence whalers and oil operators have mitigated such potential effects and may continue to do so.

Access to subsistence resources, subsistence-hunting areas, and the use of these resources could change, if oil development reduces the availability of resources or alters their distribution patterns. Cumulative effects to bowhead and beluga whales are a serious concern. If increased noise affected whales and caused them to deflect from their normal migration routes, they could be displaced from traditional hunting areas, and traditional harvests could be adversely affected. Ideally, ongoing seismic operations are seasonally timed and monitored to minimize conflicts with the migration and the subsistence hunt. In addition, although seismic and drilling noise from Alternative I for Sale 193 deepwater activities are projected and deflection of whales further offshore is possible, timing and siting concerns in the past have been accommodated in Conflict Avoidance Agreements 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 and other marine mammals. Existing and proposed projects would examine the timing and monitoring of potential noise sources to prevent conflicts to whales and subsistence whalers (USDOJ, MMS, 2003a).

If 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 spring migration, summer feeding, and fall migration could disrupt the bowhead hunt for an entire season, even though whales potentially still would be available. Tainting concerns also would apply to beluga whales, walrus, seals, birds, fishes, and polar bears. 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. A large oil spill could cause potential short-term but significant adverse effects to long-tailed ducks 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 an oil spill could reduce their availability locally to subsistence users (USDOJ, MMS, 2003a).

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. Limited data also limit our assessment of the effectiveness of mitigation measures. Any monitoring regime should incorporate 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; Miller, 2001). These trends show why it is vital to monitor subsistence resources and harvests (USDOJ, MMS, 2003a).

Many other events have combined with the area's oil development to bring rapid social change to the area including ANCSA and ANILCA legislation, the formation of the NSB, the AEW, and other local and regional institutions. It is important to note the difficulty in disaggregating the cumulative effects of oil development in the region from these other relatively recent processes of extreme local social change (USDO, MMS, 2003a).

Nevertheless, according to Worl, writing in one of the early research reports of contemporary subsistence uses by Inupiat people, the "fate of subsistence lies not so much at the level of the hunter pursuing his game, but rather at the level of external pressures impacting his environment and regulatory actions that restrict his subsistence pursuits" (NSB, 1980; Berger, 1988).

IV.C.12.a. Native Views Concerning Cumulative Effects on Subsistence-Harvest Patterns.

Cumulative effects from oil development have been, and continue to be, paramount concerns for North Slope residents. Anxiety about the possibility of nearshore and offshore oil exploration and development activity is itself an accumulating effect (NRC, 2003b:148). Public testimonies that contain a wealth of traditional knowledge are found in public hearings for MMS Chukchi Sea Sale 109 at <http://www.mms.gov/alaska/ref/publichearingsChukchi/PublicHearings.htm> and at <http://www.mms.gov/alaska/ref/PublicHearingsArctic/PublicHearings.htm> that contains 25 years of public testimony related to activities on the OCS, as well as onshore. These sites are incorporated by reference and the quoted passages below come from these two sources. For another valuable summary of North Slope testimony on North Slope oil development activities see the Native Voices section to Miller, Smith and Miller's (1993) *Oil in Arctic Waters: The Untold Story of Offshore Drilling in Alaska*.

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 USDO, 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; USDO, MMS, 2003a).

The late Thomas Napageak, Nuiqsut Native Village President and Chairman of the AEW, 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.; USDO, MMS, 2003a).

At a scoping meeting in Nuiqsut for the original 1998 Northeast NPR-A Integrated Activity Plan (IAP) and 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" (USDO, BLM, 1998a). At a BLM symposium on the NPR-A 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 USDO, BLM, 1998b). 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 USDO, MMS, 1999, 2003a).

Kaktovik resident Michael Jeffrey, testifying at the first MMS lease sale for 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 USDOJ, BLM, 1978b; USDOJ, MMS, 2003a).

The NSB sent written scoping comments and recommendations on the BLM's Northeast NPR-A IAP EIS 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. (NSB, 1997; USDOJ, MMS, 2003a)

Barrow Mayor Ben Nageak spoke at public hearings for the NPR-A IAP 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 USDOJ, BLM, 1998c). 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 USDOJ, MMS, 1998). At the same meeting, Maggie Ahmaogak, Executive Director of the AEW, asked that MMS take into account cumulative risks (USDOJ, MMS, 2003a).

A North Slope Inupiat expressed concerns about changes in migration behavior he attributed to pipelines when he said:

If you—with these animals already being displaced, now it's starting to be from Cross Island to Teshekpuk that I've noticed these animals, over a period of time, going away. And then there—right now, we're having a real hard time 'cause of the pipelines from Oliktok to Kuparuk. There's a 13-mile pipeline that's about three-feet high that, itself, already has displaced our caribous in the village. We already had a hard time with the geese already going away from these facilities. I watched these firsthand over a 15-year period, and this is what got me to move from Nuiqsut to Barrow, is observing these oil activities that's occurring. In addition to this 13-mile pipeline I'm talking about, with the new discoveries that already occurred south of the Kuparuk field, we have about another over 10-mile pipeline again, that that's three feet high. And then you look at the caribous when they—when they're trying to get to the ocean side, they're always migrating, keeping away from these bugs and everything. They stop right at Oliktok. They—we don't see those anymore, these thousands of migrating caribous. Now, at the same time, we're seeing hundreds" (Frederick Tukle Sr. 2001 Liberty Scoping, Barrow (Tukle 2001 as cited in USDOJ, BLM, 2004).

The issue of BLM's failure to resolve local allotment claims is a serious long-term concern. There also are concerns about past contamination and potential new contamination of watersheds from oil exploration (Leavitt, 1980; Aiken, 1997; (USDOJ, BLM and MMS, 1998, 2003; USDOJ, BLM, 2004, 2005).

Native bowhead and beluga whale hunters in communities in the Chukchi Sea region maintain that they also will be affected if important marine mammals are harmed. 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 (USDOJ, MMS, 2003a).

The following is a summary of effects of oil spills, disturbance, and habitat loss on subsistence resources.

IV.C.12.b. Effects of Large Oil Spills and Disturbance on Subsistence Resources.

Bowhead Whales. Effects of a large oil spill in Federal or State waters most likely would result in nonlethal temporary or permanent effects. However, we reiterate that due to the limitations of available information and due to the limitations inherent in the study of baleen whales, there is uncertainty about the range of potential

effects of a large spill on bowhead whales, especially if a large aggregation of females with calves were to be contacted by fresh oil. The NMFS has concluded that, given the abundance of plankton resources in the Beaufort Sea, it is unlikely that the availability of food resources for bowheads would be affected. Because of existing information available for other mammals regarding the toxic effects of fresh crude oil, and because of inconclusive results of studies on cetaceans after the EVOS, we are uncertain about the potential for mortality of more than a few individuals. Such potential probably is greatest if a large aggregation of feeding or milling whales, especially an aggregation containing relatively high numbers of calves, was contacted by a very large slick of fresh oil. Such aggregations occasionally have been observed in open-water conditions north of Smith Bay and Dease Inlet, near Cape Halkett and other areas.

Available information suggests that the potential for oil-industry activities outside of the Chukchi Sea to contribute to cumulative effects on this stock of bowhead whales is still limited. This remains the case. Industry has not expressed interest in the Norton Basin or Hope Basin Planning Areas. None of the Bering Sea area currently is open for leasing. The North Aleutian Basin Planning Area currently is under study for future leasing.

Available data do not indicate that noise and disturbance from oil and gas exploration and development activities since the mid-1970's had a lasting population-level adverse effect on bowhead whales. Data indicate that bowhead whales are robust, increasing in abundance, and have been approaching (or have reached) the lower limit of their historic population size at the same time that oil and gas exploration activities have been occurring in the Beaufort Sea and, to a lesser extent, the Chukchi Sea. However, data are inadequate to fully evaluate potential impacts on whales during this period, including the duration of habitat use effects or numbers and types of individuals that did not use high-use areas because of the activities. Oil and gas exploration activities, especially during the 1990's and early 2000's have been shaped by various mitigating measures and related requirements for monitoring. Such mitigating measures, with monitoring requirements, were designed to, and probably did, reduce the impact on the whales and on potential impacts on whale availability to subsistence hunters. We assume future activities in Federal OCS waters will have similar levels of protective measures. However, we cannot be certain of what mitigating measures will be imposed in State waters or what the impacts of land-related support activities will be. We also note that the effectiveness of mitigations is not entirely clear, it also is not clear when, or if, the level of activity might become large enough to cause effects that are biologically significant to large numbers of individuals. Looking at each action separately indicates that there should not be a strong adverse effect on this population. Future activity in the OCS has the potential to contribute a substantial increase in noise and disturbance that will occur from oil and gas activities in state waters and on land as well as increase the spill risk to this currently healthy population. It is not clear what the potential range of outcomes might be if multiple disturbance activities occur within focused areas of high importance to the whales.

Overall, seismic surveys are likely to result in some incremental cumulative effects to bowhead whales through the potential exclusion or avoidance of bowhead whales from feeding or resting areas and disruption of important associated biological behaviors. However, the impact analysis of the likely range of effects and the likelihood of exposures resulting in adverse behavioral effects supports a conclusion that the activities would result in no more than temporary adverse effects and less than stock-level effects. Mitigation measures imposed through the MMPA authorizations process are designed to avoid Level A Harassment (injury), reduce the potential for population-level significant adverse effects on bowhead whales, and avoid an unmitigable adverse impact on their availability for subsistence purposes. The MMS developed additional measures to help reduce the level of uncertainty during the conduct of the seismic-survey activities, which provide yet another level of mitigation and protection. Therefore, MMS concludes that seismic surveys, especially as mitigated under the Proposed Action alternatives, are not expected to add significantly to the cumulative impacts on bowhead whales from past, present, and future activities. (see Sec. V.C.6, Threatened and Endangered Species; USDO, MMS, 2003a).

The International Whaling Commission (IWC) sets the quota for the number of bowhead whales that Alaska Eskimos may harvest. This quota is based on both the biological status of the bowhead whale stock as well as the documented Alaska Eskimo cultural and subsistence need for bowhead whales. It is likely that the IWC would perceive increased industrialization of the NPR-A and rest of the North Slope, including development of coastal staging areas, heightened interest in adjacent offshore areas, and increased oil-spill risks, as placing increased pressure on the endangered bowhead whale population. As industrialization proceeds along the Alaska North Slope, it will increase noise, vessel traffic, and the potential for an oil spill in the Beaufort Sea. In

response to concerns that noise, vessel traffic, and the potential for a catastrophic oil spill poses a threat to the feeding grounds of the western Pacific gray whales, the IWC already has passed a resolution that the onset of oil and gas development programs is of particular concern with regard to the survival of this population. Because the North Slope is the fall migration path and feeding grounds of the bowhead whale, it is likely that the IWC would seriously consider the effects of industrialization on the bowhead whale population. Although the IWC is unable to directly control industrial activities, they are able to control the Alaska Eskimo subsistence harvest quota and could reduce this quota as a means of protecting the species confronted with the effects of increased industrialization. If the IWC considers the threat of industrialization large enough, it could reduce the Alaska bowhead whale quota to protect the stock. This quota reduction would have a serious subsistence and cultural effect on the Iñupiat communities of the North Slope as well as to the Iñupiat in other communities who receive whale meat from the harvest (USDOJ, BLM, 2005).

Beluga Whales, Seals, and Other Marine Mammals. Considering ongoing assessments of climate change, cumulative impacts will focus primarily on the effects of climate change. We identify ringed seals and other ice-dependent pinnipeds as being particularly vulnerable to the impacts of continued climate change and conclude that the potential cumulative effects on them are a primary concern and warrant continued close attention and effective mitigation practices.

Cumulative noise sources that could affect beluga and gray whales would be 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 likely would not reach many migrating beluga or gray whales. Noise also would be unlikely to affect the few whales that could be in lagoon entrances or inside the barrier islands because of 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 would not be likely to affect beluga or gray whales.

An important habitat for marine mammals is the active-ice, or ice-flaw, zone. Seals, walrus, and beluga whales would be most vulnerable to spills contacting this zone; polar bears would be most vulnerable to spills contacting the flaw zone or the coast. Offshore spills would obviously pose a higher risk to marine mammals than onshore spills, but along the coast of the Planning Area, some aggregations of seals and walrus and a small number of polar bears could be contaminated by onshore spills that reach marine waters and could suffer lethal or sublethal effects. The most noticeable effects of potential oil spills from offshore oil activities would be through contamination of seals, walruses, and polar bears, with lesser effects on beluga whales.

Traditional knowledge as related by some hunters in northwestern Alaska affirms that construction and operation of the portsite for the Red Dog Mine has affected the subsistence harvest of belugas in the Chukchi Sea around the port site. The total harvest of beluga whales by hunters from Kivalina dropped off between 1984 and 1987, before construction began at the port site and has continued to be relatively low. In other marine waters of Alaska, belugas have tended to adapt to industrial and transportation noises after they have learned such noises do not represent a direct threat (Huntington and Mymrin 1996). Reports by Kivalina hunters indicate that either belugas of both spring and summer stocks have not yet become acclimated to structures or activities at the Red Dog portsite or that other factors have reduced Kivalina's beluga harvest since construction began in the late 1980's. While data from the Beaufort Sea and Cook Inlet, indicate that the presence and operation of marine transportation facilities have not caused long-term avoidance by belugas, the Kivalina combined spring and summer subsistence harvest declined about the time the facilities were constructed and have remained below preconstruction levels in most years since then. Other factors figuring into the decline of the beluga hunt could include: long-term changes in ice conditions, beluga mass mortality reported in Siberian waters, and changes in beluga response to increased noise and activity (U.S. Army Corps of Engineers, 2005; Huntington, 1999).

Oil and gas activities, increasing concentrations of contaminants in the Arctic, and large volume fish removals in the Bering Sea also may be affecting marine mammal populations. Marine mammals also face increased industrial development and increased human activity in the Arctic, which likely will interact synergistically in a cumulative fashion. There is a high degree of uncertainty regarding the spatial scope of potential industry activities on the Alaskan OCS. However, the proposed activities will increase the overall industry footprint and

add to the amount of industry activity in the sale area (See Sec. V.C.8, Other Marine Mammals; USDOJ, MMS, 2003a).

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 would continue to displace some caribou during the calving season within about 2.5 mi from 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 (CAH) 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, do not include roads constructed to Prudhoe Bay and the Dalton Highway.

A number of large-scale developments are being considered for northwest Alaska. Potential impacts of individual projects on terrestrial animals should not be evaluated in isolation. Instead, the cumulative effects of all existing and proposed development should be considered collectively over the short and long term to predict impacts on animals. Because no large-scale, long-term monitoring system has been established on the North Slope, information gaps make it hard to assess the full extent of cumulative effects. A major concern regarding land management in the western Arctic is that the same pattern of incremental, piecemeal development that has occurred in the central Arctic will be repeated as industry moves westward. In the absence of a comprehensive conservation strategy, expanding industrial development over the next 25-50 years may have significant impacts on individual animal populations, subsistence use opportunities, and the integrity of the greater ecosystem. The Western Arctic Caribou herd (WAH) can be considered a "keystone" population, in that it provides critical resources for many other species sharing the ecosystem and is an important subsistence resource for as many as 40 Native villages within the herd's annual range (Schoen and Senner, 2003). Therefore, careful consideration must be given to the impact of potential developments to this herd (see Sec. V.C.9, Terrestrial Mammals; USDOJ, MMS, 2003a).

A hunter from Nuiqsut commented on effects to the CAH: "The vibration of horizontal drilling bothers animals and makes them afraid. The migration route of the Central Arctic [caribou] herd changed because of this" (S.R. Braund and Assocs., 2003, Field Interviews, USDOJ, BLM, 2004).

Cumulative impacts to caribou could be reduced by not allowing leasing in the most sensitive areas; by consolidating facilities (especially reducing the number of roads); by reducing the footprint of development; by prohibiting roads between fields; and by restricting surface and air traffic, humans on foot, and other activities during the calving season.

Birds. The cumulative effect of seismic exploration on marine and coastal birds probably would be moderate, particularly to birds staging or molting in the Ledyard Bay area. The cumulative effect of disturbance due to seafloor sampling and drilling platforms probably would be minor, due to displacement from surface areas, such as Ledyard Bay. The cumulative effect of exploratory discharges probably would lead to low effects in offshore locations. The discharge of produced water year round anywhere probably would lead to moderate effects as contaminants on the surface could impact birds in the vicinity of the discharge sites. Discharges in nearshore Arctic Ocean waters have not been approved by USEPA, but any discharge proposals would be reviewed in detail by MMS and USEPA. We assume an extensive system of pipelines for offshore developments would impact several hundreds of acres of bird molting and foraging habitat impacted during construction and this activity would be a major, but short-term impact that would result in the displacement of staging and molting birds from nearshore areas. Inspections, over time, could result in temporary displacement effects.

Such disturbance effects would be reviewed further by the MMS and the U.S. Army Corps of Engineers, but we also assume that the effects of an alternative to production pipelines—the transportation of produced oil in vessels—would be much worse. If a large oil spill contacted the Chukchi Sea coastline, the oil probably would persist in the tidal and subtidal sediments for a couple decades, leading to a significant long-term impact to marine and coastal birds and their nearshore habitats either directly important or immediately adjacent to areas holding tens of thousands of birds during critical lifestages, such as migration, nesting, molting, and brood-rearing. During the abandonment phase, we assume that the offshore pipelines would be cleaned, plugged, and abandoned in place. For purposes of analysis, one large spill was assumed to occur and is analyzed in this EIS. Overall, the cumulative level of effect on marine and coastal birds would be significant in most cases. A large

oil spill would likely impact marine and coastal birds and their habitats for decades and could result in the loss of discrete breeding populations of several species along Chukchi Sea coast (see Sec. V.C.7, Marine and Coastal Birds; USDO, MMS, 2003a).

Fishes. The cumulative effect of seismic exploration on fish resources probably would be minor. The cumulative effect of disturbance due to seafloor sampling and drilling platforms also would probably be minimal and would be further reviewed by MMS in future installation proposals. The cumulative effect of exploratory discharges probably would lead to low effects in offshore locations. The year-round discharge of produced water anywhere probably would lead to moderate effects. Discharges in nearshore Arctic Ocean waters have not been approved by USEPA, but any discharge proposals would be reviewed in detail by MMS and USEPA. We assume an extensive system of pipelines for offshore developments that would disturb several thousand acres of typical benthos for less than a decade, depending on specific location, which could lead to a moderate effect.

Disturbance effects would be further reviewed by MMS and the U.S. Army Corps of Engineers, but we assume that the effects of an alternative to production pipelines—the transportation of produced oil in vessels—would be much worse. If a large oil spill contacted the Chukchi Sea/Arctic Ocean coastline, the oil probably would persist in the tidal and subtidal sediments for a couple decades, leading to a significant long-term impact to nearshore habitats to spawning and rearing fish. During the abandonment phase, we assume that offshore pipelines would be cleaned, plugged, and abandoned in place. For purposes of analysis, one large spill was assumed and, overall, the cumulative level of effect on fish resources would be moderate in most cases. A large oil spill likely would impact certain spawning and rearing habitats for decades. These impacts could result in varying degrees of population-level effects to different species, including the loss of several discrete runs of pink, chum, and coho salmon along the Chukchi Sea coast (see Sec. V.C.4, Fish Resources; USDO, MMS, 2003a).

Polar Bear. The main effects of concern to polar bears are climate change, overharvest, and oil and fuel spills. Considering ongoing assessments of climate change in the Arctic, the biological analysis for polar bears concludes that the potential effects of climate change on polar bears are a primary concern, and warrant continued close attention and effective mitigation practices. Polar bears also face impacts from increased industrial development and increased human activity in the Arctic which would likely affect them synergistically. Quantitative data that specifically address potential cumulative impacts of development on polar bears and the effects of disturbance related to human activities on polar bear habitat, recruitment, and survival are lacking. There also is a high degree of uncertainty regarding the spatial scope of potential industry activities on the Alaskan OCS. However, the proposed activities would increase the overall industry footprint and add to the amount of industry activity in the sale area (see Sec. V.C.8, Other Marine Mammals; USDO, MMS, 2003a).

V.C.12.c. Subsistence Resources and Practices.

Given the level of potential seismic-survey activity described in the scenario and past assessments of species, potential effects from large oil spills, and resource effects discussed in Section IV.C1.1, Subsistence-Harvest Patterns, whales, seals, walrus, caribou, and polar bears might be displaced and their availability affected for an entire harvest season, potentially causing significant impacts. However, in-place protective mitigation for Sale 193, stipulated measures for seismic-survey permits, and mitigation accompanying NMFS Incidental Harassment Authority (IHA) ensures that Conflict Avoidance Agreements will be in place and that acceptable levels of whale monitoring will occur. Together, these measures should ensure that no unmitigable adverse effects from seismic survey activity to subsistence-harvest patterns, resources, or practices will occur. Large oil spills, if they occurred, would present significant impacts to subsistence resources and practices.

Other noise and traffic disturbance from offshore facilities may affect marine-subsistence activities. In the cumulative case, the increased amount of oil-related traffic makes it likely that subsistence-harvest activities could be disrupted occasionally by boat and air traffic. Because most marine-hunting activity occurs within a wide area of open water, such interruptions typically may cause boat crews to hunt longer or take extra trips but are not expected to significantly reduce overall harvests of marine mammals or seabirds. The one exception could be walrus where, in recent years, local hunters have noted that the abundance of walrus in retreating spring pack ice has declined coincidental with the appearance of large tugs pulling supply barges (USDO, FWS, 2006).

Because of their short and ice-condition-dependent seasons, bowhead whale harvests are more likely to be affected by noise and traffic disturbance than are other forms of marine mammal hunting (other than beluga whaling). Because the bowhead whale harvest in all communities except Barrow tends to be quite small—one to two whales per year—noise disturbance from icebreakers and other vessels could cause this small harvest to become locally unavailable for the entire season. Such activities already occasionally have affected subsistence hunting. For example, Kaktovik whalers stated that their 1985 fall whaling season was adversely affected by vessels related to oil development operating in open-water areas. Effects from noise and disturbance on the beluga whale harvest could increase under the cumulative scenario. Increased air traffic and vessel activities in the Chukchi Sea could impact the beluga harvest by causing beluga whales to become locally unavailable for certain critical periods.

Access to subsistence resources and subsistence-hunting areas and the use of subsistence resources could change if cumulative noise and traffic disturbance reduces the availability of resources or alters distribution patterns. Cumulative effects to bowhead whales are 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. Historically, bowhead whales have been exposed to multiple sources of human-caused noise disturbance and are likely to be exposed to similar sources of noise disturbance in the foreseeable future. Required protective mitigation is expected to reduce these noise disturbance impacts. In any areas where the subsistence hunt could be affected, stipulations, required mitigation, and conflict avoidance-type measures under IHA requirements, as defined by NMFS and FWS, have, in the past, worked toward avoiding unreasonable conflicts or disturbance to subsistence activities and have required operators to demonstrate that no unmitigable adverse impacts occur to subsistence resources and practices. Conflict avoidance agreements between operators and the AEWG ensure that seismic operations are seasonally timed and monitored to prevent conflicts with the bowhead whale migration and the subsistence hunt.

V.C.12.d. Cumulative Effects on Habitat.

On the North Slope, development has directly covered about 7,000 acres through the construction of 350 mi of roads, 89 pads, 4 airstrips, and 14 gravel mines. The mines cover more than 1,500 acres. Development in the Prudhoe Bay and Kuparuk areas directly has 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. Development on the scale of Prudhoe Bay in the Chukchi Sea region has not occurred and consequent habitat destruction is not presently an issue, except possibly in the vicinity of the red Dog Mine near Kivalina and chronic habitat contamination from industrial pollution in many coastal areas on the Russia Chukotka coast (USDOI, MMS, 2003a; Berger, 1988; Chance and Andreeva, 1995).

Offshore production-platform construction, trench dredging, and pipeline burial are expected to affect some benthic organisms and some fish species within 1 km for <1 year or season. These activities also temporarily may affect the availability of some local food sources for these species up to 1-3 km (0.62-1.9 mi) 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, although 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 CAH's calving range actually have destroyed only about 3-4% of the tundra grazing habitat for caribou (USDOI, MMS, 2003a).

There is great concern among Inupiat that subsistence and cultural sites could be damaged because of such a sweeping undertaking as a road. In BLM's 1979 Section 105 (c) study of NPR-A, the Inupiat Community of the Arctic Slope stated in The Inupiat View:

Areas identified in the TLUI (Traditional Land Use Inventory) as critical to subsistence or cultural sites should be off limits to any oil and gas exploration and development activities, including transportation systems. Activities proposed outside these sites should be evaluated on a case-by-case basis in close cooperation with local residents and representatives of the Borough and ICAS; for in

order to mitigate the effects of such disruption and alien uses, in a special environment of great significance to many people, requires special knowledge that only we can provide" (USDOI, BLM, 1979b).

In Hall's 1983 subsistence study for the proposed Brontosaurus exploratory well in NPR-A, many Inupiat were interviewed about their concerns regarding potential impacts from the project. Overwhelmingly, the most threatening factor was the potential contamination of the local watershed and subsequent impacts on local fisheries in the Inaru River drainage. According to Hall, one subsistence hunter felt that the Inaru basin was "akin to the ocean, being an extreme example of a wetlands and providing a feeding ground for the Inupiat." Those interviewed believed that "White scientists" were ignorant about the entire Inaru drainage, "particularly in terms of the nature and intensity of water movement and sediment transport." According to local residents, the watershed is a complicated web of lakes north and south of Niklavik Creek and the Inaru River connected by small streams that could be navigated by fish at high water. They believed that contamination of any single waterbody "whether directly or indirectly by run-off from the land" would ultimately affect any part of the downstream drainage. In addition, ice jams on the Meade River delta could cause water to flood back up the Inaru as far as Niklavik Creek, effectively bringing any contaminants upstream from their origin. To local Inupiat, the Inaru drainage was a unique yet susceptible aquatic resource. Flossie Itta stressed this point in an interview by Hall when she spoke of her grandparents warning her as a child to not even dispose of soapy wash water in local waterbodies because it could harm or frighten fish (Hall, 1983). These observations suggest that local subsistence-based communities would have major concerns with a potential permanent road between development sites in the northeastern portion of the Northwest NPR-A Planning Area. This road could compound run-off impacts over a much more widespread area, potentially affecting lakes, streams, and major rivers and threatening local subsistence fisheries.

As part of the fieldwork protocol for a 1984 MMS technical report entitled *Barrow Arch Socioeconomic and Sociocultural Description*, researchers asked people in various Chukchi Sea villages their opinions on building land links between local communities and other regions of the North Slope. The majority of the people interviewed opposed land links to villages because (1) they appreciated the quality of life afforded them by semi-isolation, (2) they believed that roads would have a negative impact on wildlife resources, and (3) they worried that road access would increase liquor imports into "dry" villages (ACI, Courtneay, Braund, 1984).

Walker et al. in their 1987 paper *Cumulative Impacts of Oil Fields on Northern Alaska Landscapes* found: (1) major landscape impacts from Prudhoe Bay development; (2) that indirect impacts such as thermokarst may not develop until many years after initial development; and (3) that the total area covered by direct and indirect impacts can greatly exceed the area of planned development. According to Walker et al. (1987): "There is a need to develop methods to assess cumulative impact and to foster comprehensive regional planning to anticipate the large impacts that are likely to occur on the coastal plain in the next few years." A permanent road would certainly represent one of these "large" impacts and would call for a massive planning effort, accompanied by the gathering of all necessary baseline data along any potential route (Walker et al., 1987; Miller, 2001; see Sec. IV.F.8.n, Cumulative Effects on Subsistence-Harvest Patterns).

In a 1987 FWS study that compared the actual and predicted impacts of TAPS, researchers concluded that:

Fish and wildlife habitat losses resulting from construction and operation of the Pipeline System and Prudhoe Bay oilfields were greatly underestimated in the [USDOI's 1972 Final] EIS [on the Trans-Alaska Pipeline]. They included the direct losses of 22,000 acres from gravel fill and excavation, the even greater indirect losses of habitat quality due to the secondary impacts of construction (dust, siltation, erosion, impoundments, contaminants, etc.), and the blockage of fish and wildlife access to habitat by roads, pipelines, and causeways. Some of these indirect impacts were not predicted in the EIS, and the observed magnitude of frequency of others were greater than expected. Although some effort has been made to reduce habitat loss (through siting, consolidation of facilities, culverting, etc.) rehabilitation efforts along the Pipeline System have resulted in little restoration of habitat values...a lack of predictive capability may be expected whenever development moves into new geographical areas (USDOI, FWS, 1987).

Potential permafrost loss and hydrological changes related to global climate change could compound impacts from road construction and maintenance. The thawing of permafrost and associated increased maintenance costs already have become problems in arctic and subarctic areas (www.grida.no/climate/ipcc/regional, 2002).

The route of a permanent road connecting potential development sites in the northeastern portion of the Northwest NPR-A Planning Area to Barrow, Cape Simpson, or Nuiqsut would pass through important subsistence resource habitat and important subsistence-harvest areas for caribou, fish, and birds. A road, combined with any development pipelines, would disrupt and displace caribou along its length and potentially disrupt hunting patterns by producing major alterations in hunter (including nonsubsistence hunter) access patterns in both summer and winter. Any road access would represent a major arterial where only trails had existed before. A road would promote the development and expansion of the oil patch, bringing with it similar issues about hunter access restrictions, hunting area reductions, trespass issues, disturbance and displacement of game, and the effectiveness of mitigation—all persistent and unresolved concerns from ongoing expansion at Prudhoe Bay, Kuparuk, and Alpine. The Dalton Highway, paralleling much of the Arctic portion of the TAPS, has provided human access into remote regions and increased hunting and off-road vehicle impacts and accompanying impacts on caribou (Bergerud, Jakimchuk, and Carruthers, 1984; Spellerberg, 1998; Ricketts et al., 1999).

A 1997 study on the proposed Eureka to Rampart road assessed impacts to subsistence resources and activities by nonlocal residents as a result of increased access from existing road projects. Effects identified in the study communities of Rampart, Stephens Village, Tanana, Eureka, Minto, and Manley Hot Springs included: (1) increased nonlocal hunter use as a result of local access using the Dalton Highway; (2) increased nonlocal pressure on the hunting of moose, bear, and waterfowl, fishing for salmon, pike, whitefish, and blackfish, and trapping; (3) increased noise activity from nonlocal hunter boat use; (4) increased minerals development; (5) State land disposals increasing homesite developments and increased populations of potential subsistence users; (6) loss of habitat for subsistence resources and loss of lands used for subsistence harvests; (7) declines in moose populations; and (8) illegal use of Native lands by nonlocal users. As a result of this increased nonlocal access and hunting pressure, many local hunters curtailed their fall moose hunt and often waited until the winter season to hunt (Betts, 1997). Similar hunting, access, and habitat pressures on subsistence resources and harvest activities could be expected from potential State or NPR-A road development on the North Slope.

In general, caribou, fish, birds, and other terrestrial mammals would be expected to experience greater and more continuous disturbance and contamination effects from a road, with those nearest the road experiencing the greatest local disturbance and displacement. In the absence of restrictive regulations, local non-oil- and gas-related activities—including inevitable non-subsistence hunting (and the eventual pressure for increased sport hunting)—would be expected to have adverse effects on subsistence resource populations and subsistence-harvest patterns.

A 175-mi-long road across the NPR-A would produce more regional (thus, more profound) effects on the habitat and movement of subsistence resources, and on hunter access. Bridging the many productive rivers from Nuiqsut west would make these watercourses more vulnerable to siltation and fuel-spill contamination. Of primary concern would be (1) the lack of any reliable process for assessing and monitoring changes to subsistence-harvest patterns, (2) changes to hunter access, and (3) enforcement of the regulations that would need to be enacted to mitigate the profound and widespread effects such an artery would bring with it (Haynes and Pedersen, 1989).

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. In addition, new roads often mean 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 (USDOI, MMS, 2003a).

Development of regional roads within the planning area would have the potential to negatively affect wildlife, and thus affect subsistence. These impacts would include habitat fragmentation, increased access into wildlife habitats, increased disturbance impacts, increased potential for mortality (road kills), and possible alteration of behavior or movement patterns of wildlife. If the proposed road(s) linked small or regional communities to the already existent road system within Alaska, then increased competition for subsistence resource likely would result, as nonlocal hunters would be able to access the area with little effort. This also may result in an increase in tourist traffic and recreational use of the area, causing additional impacts to wildlife. Small roads that connect communities within the planning area might aid subsistence users in accessing their traditional harvest

areas. However they also might concentrate hunting efforts along the road corridor, thus depleting resources from the area and potentially altering harvest from currently used traditional harvest areas (USDOI, BLM, 2006).

Any local or more extensive interconnecting road system could bring impacts from increased access to subsistence resources. More specifically, increased access could increase hunting pressure and increase competition for subsistence resources from both subsistence and nonsubsistence hunters. Increased harvest levels potentially could make game scarcer near the road proper. Reduced abundance and distribution of caribou and other terrestrial mammals would be expected along the road corridor from hunting, trapping, recreation, and tourist traffic associated with an interconnecting road. Increased hunting pressure in areas of high goose concentration could lead to declines in bird use of these areas. As a result of increased hunting pressure and reduced abundance, hunts could take longer as hunters would have to travel farther from the road corridor to successfully reach game or be forced to hunt in nontraditional areas. On the other hand, access could be diminished for subsistence hunters if the same problems were to arise in unitized oil fields where subsistence access has been curtailed near development sites by enforced no-fire zones (Chance and Andreeva, 1995; USDOI, BLM, 2004; Miller 2001).

V.C.12.e. Transportation Effects on Subsistence-Harvest Patterns.

Small Onshore Spills from the Trans-Alaska Pipeline System. Considering the small additive effects of onshore oil spills from the TAPS on individual subsistence resources, measurable cumulative effects on subsistence harvests are not expected.

Small onshore spills 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 Chukchi Sea region. In winter, onshore pipeline spills on the North Slope and along the TAPS 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 would 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 have 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 exposed vegetation (USDOI, MMS, 2003a).

Summary and Conclusion for Chukchi 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 Inupiat subsistence users 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 event 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 spring migration, summer feeding, and fall migration 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, Wainwright, Point Hope, and the beluga whale hunt in Point Lay 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 walrus, seals, and polar bears. Native harvests of bowhead and beluga whales, walrus, seals, and polar bears by subsistence hunters in the Chukchi Sea region also would be affected by tainting concerns.

Additionally, in the event of a large oil spill, potential short-term but significant adverse effects could be expected to long-tailed ducks and king and common eider populations. A large onshore pipeline spill that contacted a major river 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. More roads on the North Slope increase non-Native access to, competition for, and disturbance of resources—a potential adverse 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.

Transportation Route. In Alaskan waters, the probable oil-tanker route lies seaward of the 200-mi Economic Exclusion Zone boundary except in the north central 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 toward 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.

Ongoing tanker transportation of oil from Valdez to the U.S. 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 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 is limited subsistence harvest activity 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.

V.C.12.f. Arctic Climate Change and Global Warming.

The Council on Environmental Quality (CEQ) bases its guidance on the NEPA regulations that mandate that all “reasonably foreseeable” environmental impacts of a proposed Federal action have to be considered in the NEPA assessment. The CEQ considers that there is adequate scientific evidence (e.g., the Fourth Assessment Report by the International Panel on Climate Change [IPCC]) indicating that climate change is a “reasonably foreseeable” impact of greenhouse gas emissions [CEQ, 1997; IPCC, 2007]).

In and of itself, greenhouse gas emissions from exploration, development, and production in the Chukchi Sea Planning Area are unlikely to significantly contribute to arctic climate change, although Chukchi Sea infrastructure is likely to bear the brunt of any significant climate change effects. In any case, these activities remain part of the long-term and additive phenomena of North Slope and Arctic oil development that will continue to play a fundamental role in the changing ecosystem of the Arctic (NRC, 2003b).

V.C.12.f(1) The Greenhouse Effect. Trapped radiation from the sun warms the lower part of the Earth's atmosphere. Some of this warmed air radiates energy up and out of the atmosphere, and some radiates down to the Earth's surface; in this way, the Earth is kept hotter than it would be without this process. This is referred to as the "greenhouse effect." Climate change concerns have arisen over the increased release of greenhouse gases by human-produced sources over natural beneficial levels and their increasing concentrations in the atmosphere. Because greenhouse gases prevent heat from escaping into space, they have contributed to artificially higher global air temperatures. A warming atmosphere and ocean make a great deal of extra energy available for the creation of weather. World weather has seen an increase in the severity of storms, droughts, rainfall, and heat waves, and such weather anomalies are expected to continue (AMAP, 1997; Kerr, 2001; USEPA, 1998; USDOJ, MMS, 2003a).

V.C.12.f(2) Greenhouse Gases: The main greenhouse-gas contributors are carbon dioxide from the burning of fossil fuels and deforestation; methane from rice paddies, farm animals, wetlands, and the production of natural gas; nitrous oxide increases from the global use of fertilizers; ozone; and manmade chlorofluorocarbons (CFC's) (harmful to the ozone layer). The main drive behind climate change is the increasing amount of carbon dioxide in the atmosphere. Its level has risen by a third since the industrial revolution started in the 1760's, and methane concentrations have more than doubled since preindustrial times. Recent studies suggest that anaerobic decay at the bottom of manmade reservoirs could be responsible for up to a fifth of global methane emissions. If decomposition of tundra exceeds primary production, large carbon pools in tundra soil could add to atmospheric carbon dioxide and climatic warming; in fact, some experts believe that this source of stored carbon, if released "could increase the atmospheric concentration of carbon dioxide by more than the cumulative contribution from fossil fuels through 1995" (AMAP, 1997; USEPA, 1998; USDOJ, MMS, 2003a; Millennium Ecosystems Assessment, 2005; United Nations Environment Programme, 2005).

V.C.12.f(3) Global Warming: If nothing is done to curb emissions of carbon dioxide, the amount in the atmosphere could double preindustrial levels by the end of the 21st Century. At current rates of release, average global temperature could raise from 2.5-10 °F (1.4-5.8 °C) by the year 2100. This rate of warming appears to be greater than any observed over the past 10 millennia. General predictions of an increasing greenhouse effect are: (1) sea level rise between 15 and 95 cm (5 and 3 ft) by 2100; and (2) more extremely warm days and fewer extremely cold days. These factors would predicate an increase in floods and droughts. Models predict that coastal regions will become wetter and interior regions will become drier. Some areas likely will experience greater effects and other areas less, but prediction models are not sophisticated enough at the present time to make accurate regional predictions of such effects (AMAP, 1997; Kerr, 2001; USEPA, 1998; National Assessment Synthesis Team, 2000; United Nations Environment Programme, 2005).

The Arctic is considered one of the most extreme environments on the planet and because sea ice, snow cover, glaciers, tundra, permafrost, boreal forests, and peat areas are all sensitive indicators of change, global climate models indicate that global warming will have its most acute impacts in polar regions (Center for Global Change, 2003). In Alaska, air temperatures have increased 4 °F since the 1950's and 7 °F in the Interior in winter. Over the past 30 years, air temperatures have increased the greatest in winter and spring in the interior of Alaska and north of the Brooks Range. Summer sea ice has decreased 3% per decade since the 1970's; multiyear sea ice has decreased 14% since 1978 and thinned 4 inches per year from 1993-1997 (Groat, 2001; *Alaska Daily News*, 1999). Breakup begins 40 days earlier in Barrow than it did 50 years ago, and permafrost has warmed by about 3.5 °F since the 1960's (Schneider, 2001).

In 1995, 2,000 scientists, experts, and government officials of the United Nations sponsored IPCC concluded: "The balance of evidence suggests that there is a discernible human influence on global climate." In 2001, they stated that "most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations...and is unlikely to be entirely natural in origin." The U.S. alone pumps out a quarter of the world's carbon dioxide emissions. Underdeveloped nations have even advanced the concept of being paid climate compensation to help them cope with the inevitable impacts of climate change from the First World nations who produce the greatest greenhouse gas emissions (NewScientist, 2002). Concern about increased global temperature has fueled recent scientific research and political debate over "global warming" and its causes and effects. Even British Petroleum's (BP's) former chief executive, John Browne, has acknowledged that the oil industry is a responsible contributor to global warming; he has pledged \$15 million to fund the 10-year Carbon Mitigation Initiative that will research how BP can better capture its carbon emissions. In July 2005, leaders of the G8 nations—the United Kingdom, France, Russia, Germany, the United States,

Japan, Italy, and Canada—issued a joint statement that committed them to take prompt action in reducing emissions of greenhouse gases (Speiss, 2000; BP, 2001; Kerr, 2001; The Royal Society, 2005).

V.C.12.f(4) Sea Ice and Snow Cover: Another factor of global climate change is its uneven distribution on the planet. Models indicate the atmosphere is heating faster at the poles than other places on the planet. In the northern part of the northern hemisphere the largest temperature rises are predicted, and they would occur in winter. Global warming would be felt most acutely in the Arctic, because diminishing sea ice and snow cover—that normally cool the climate by reflecting solar energy back to space—would cause the greatest relative temperature increases. Since the 1950's, the extent of sea-ice in the northern hemisphere during spring and summer decreased by about 10-15%, and a decline of 40% in arctic sea-ice thickness during late summer and early autumn has occurred during the past several decades. In the Beaufort Sea, the loss of ice has been dramatic. In 1996, there was 300,000 km² of open water; this rose to 700,000 km² in 1997 and 970,000 in 1998 (Talbot, 2000). Changes in ice and snow cover would, in turn, affect local weather, cloud distribution, and ocean circulation (AMAP, 1997; *Anchorage Daily News*, 1999). Polynyas could become bigger and their numbers increase. With more open water, more moisture would be lost to evaporation and cloud cover would increase. Increased cloud cover could decrease the amount of solar energy reaching the earth and actually slow down the warming trend. In September 2003, the Arctic's largest ice shelf showed its first signs ever of breakup, and a study by NASA has actually predicted that the Arctic Ocean will be completely devoid of summer ice before the 21st Century has ended (Mason, 2003; NASA, 2002). These Arctic alterations would then be expected to affect global climate, although the models and mechanisms for predicting actual global consequences are still not clearly understood. Are observed temperature changes in the Arctic directly related to global warming? The answer is not clear, because data often are not known for extensive time periods and, when data are available, often they are not comparable. To separate trends due to global warming from those due to normal climatic variation is difficult, although recent studies report that warming trends and the decrease in ice cover over the last 2 decades cannot be explained by natural processes alone (AMAP, 1997; USEPA, 1998; Vinnikov et al., 1999; Johannessen et al., 2002; United Nations Environment Programme, 2005; Callaway, 2007).

Ice also serves as a barrier to wind and wave action and limits their effects. Less arctic ice means more wave action that can cause more erosion on arctic shores. Later ice freezeup and earlier melting further would increase active wind and wave action. Less ice and warmer air could increase cloud formation and alter regional weather patterns, although predicting the influence of clouds and large-scale weather changes still are very problematic with present modeling. In terms of carbon dioxide exchange from the ocean into the air, ice is a limiting factor. Ice also limits the penetration of light into water; extensive sea-ice changes and increased light could influence the production of sea algae (see section on ultraviolet radiation below) (AMAP, 1997; USEPA, 1998).

V.C.12.f(5) Observed Arctic Effects: Besides sea-ice effects, observed Arctic changes include: (1) increased snowfall; (2) drier summers and falls; (3) forest decline; (4) reduced river and lake ice; (5) permafrost degradation; (6) increased storms and coastal erosion; (7) cooling in the Labrador Sea (associated with increased sea ice melt); and (8) ozone depletion. Precipitation in the Arctic has increased 15% in the past 40 years, and there is a trend toward an earlier spring melt (AMAP, 1997). Permafrost degradation and thermokarsting will continue to cause forest damage, roads and buildings to sink, riverbanks to erode, and alterations in tundra vegetation. The IPCC studies show that Arctic warming trends are allowing boreal forests to expand northward at about 100-150 km/°C of average temperature increase and, although forests may be expanding northward, warming has increased the incidence of forest fires and damage from insect infestations. Extremely warm temperatures sparked widespread wildfires in the Canadian Arctic during the summer of 1995—the hottest June in Canada's recorded history—forcing the evacuation of Tulita, a small MacKenzie Basin community (Peterson and Johnson, 1995). Warmer temperatures on Alaska's North Slope are promoting the growth of dwarf birch, alder, and willow shrubs (Schneider, 2001). A very visible recent impact of climate change on boreal forests is the destruction since 1987 of nearly 4 million acres of mature white spruce on Alaska's Kenai Peninsula by the spruce bark beetle. Temperature increases have allowed the beetle to flourish. Increased freshwater runoff from arctic rivers is making seawaters fresher, while the salinity of equatorial waters is increasing. Many climate experts believe this increased precipitation and icemelt in the north and increased evaporation in the south marks a true change in climate. This process also could contribute to the greenhouse effect because, as warming reduces ice formation, currents could slow, less water could be transported, and less carbon dioxide taken out of the atmosphere (AMAP, 1997; USEPA, 1998; National

Assessment Synthesis Team, 2000; Groat, 2001; Environment Canada, 1997; Parmesan and Galbraith, 2004; The Wildlife Society, 2004; Millennium Ecosystems Assessment, 2005; Smith, 2006; Callaway, 2007).

Ozone Depletion: Ozone is an atmospheric gas that blocks harmful ultraviolet radiation (UV) from reaching the Earth. At present, the stratospheric concentrations of ozone are decreasing, and the highest rates of reduction are occurring in the polar regions. The emission of CFC's is the major culprit in depleting the ozone layer, although a general downward trend in ozone depletion measured at 8% per decade in the winter and spring has been documented. In addition, ozone reductions change the atmosphere's temperature regime, and temperature changes produce alterations in climate. Such climate change may actually feed ozone depletion in the Arctic by cooling the stratosphere and changing circulation patterns that bring low-ozone air northward. This general ozone depletion raises concerns about the overall light environment and potential health effects to humans, as well as Arctic plants and animals (AMAP, 1997; USEPA, 1998).

UV Radiation: Potential human health effects from UV radiation stem from the fact that arctic snow cover reflects back up to 90% of the UV radiation; cloud layers also can reflect UV radiation back to the snow, and this back and forth reflection process can increase the UV effect even more. In general, UV exposure is doubled by snow cover. Increased incidents of snow blindness could occur and increase the risk to eye diseases. For each 1% decrease in ozone, the risk of skin cancer increases 2.5% (in a white population), but by adding reflected light to the process, the risk rises to 3.2%. Normally, indigenous peoples of the Arctic are less at risk because of their darker skin and the extent to which they wear protective clothing. The UV radiation also been shown to suppress the immune system in the skin, which can lead to skin cancer. Clouds can shield UV exposure as can human-produced emissions of sulfur dioxide that form the UV-blocking sulfate aerosols in arctic haze (AMAP, 1997; Cahill and Weatherhead, 2001).

Increased UV radiation produces a variety of effects on arctic flora; likely long-term changes would be UV-tolerant species gaining a competitive edge on those species less tolerant and an overall alteration in the composition of the floral community. The UV exposure can slow down decomposition of plant matter, and increased UV radiation in the Arctic could slow the entire plant-nutrient cycle. The UV radiation stresses plankton growth in freshwater ecosystems and makes it less digestible to zooplankton. The growth of marine algae can be reduced by increased UV radiation, but current research cannot predict overall regional productivity changes. Zooplankton can be very sensitive to UV radiation, and UV increases likely would impact the more sensitive species the most, causing reductions in abundance and alteration in food webs. Fish that produce eggs or larvae in shallow waters in the spring or marine species that have eggs floating close to the sea surface could be particularly vulnerable to UV radiation. Larger marine and terrestrial mammals have not been adequately studied as to UV effects, but potential harm could come from the exposure of eyes and skin areas unprotected by fur or feathers (AMAP, 1997; Cahill and Weatherhead, 2001; Callaway, 2007).

There is mounting speculation that increasing UV radiation actually could increase carbon dioxide production in rivers, lakes, wetlands, and marine waters, which could lead to an increased concentration of carbon dioxide in the atmosphere. Such an increase of carbon dioxide would exacerbate the greenhouse effect (AMAP, 1997).

Infrastructure: Permafrost thawing will continue to damage roads and buildings and contribute to eroding coastlines and increase building and maintenance costs. Already the cost of shifting buildings, broken sewer lines, buckled roads, and damaged bridges causes \$35 million worth of damage in Alaska annually. In Kotzebue, the local hospital had to be relocated because it was sinking into the ground (ARCUS, 1997). Sea-level rise and flooding will threaten buildings, roads, and powerlines along low Arctic coastlines, and combined with thawing permafrost, it can cause serious erosion. Kaktovik's 50-year-old airstrip has begun to flood because of higher seas and may need to be moved inland (Kristof, 2003). Shore erosion in Shishmaref, Kivalina, Wainwright, and Barrow in Alaska and Tuktoyaktuk at the mouth of the Mackenzie River in Canada has become increasingly severe in recent years, as sea-ice formation occurs later, allowing wave action from storms to cause greater damage to the shoreline. Eventually, some of these communities will be forced to relocate. The duration of ice-road usefulness in the Arctic already has diminished by weeks and has led to an increased need for more permanent gravel roads. Gravel roads, however, are more prone to the effects of permafrost degradation, thermokarst, and consequent settling that increases maintenance costs. Gravel roads also contribute to the fragmentation of landscapes and habitats that can lead, through time, to reduced species' productivity. Such an impact on species is a threat to subsistence livelihoods. Oil companies have reported that warming arctic temperatures make the operation of oil-field compressors less efficient and reduce oil production. Unstable permafrost could affect undersea pipelines; sea-level rise could compromise the

effectiveness of gravel production islands and submerge barrier islands that afford protection to nearshore production sites; an increase in storm severity combined with longer periods of broken ice also could increase the threats to these facilities and add difficulty to oil-spill cleanup. More positive effects from global warming include the possibility of an ice-free shipping route through the Northwest Passage; shipping products from Japan to Europe would save 10-15 days. In addition, less sea ice likely would facilitate oil exploration and extraction (NRC, 2003b; Smith, 2000; Brown, 2003; Schneider, 2001; Crary, 2002; USDOJ, BLM, 2002; Hopkins, 2003; New Scientist, 2001; *Anchorage Daily News*, 2002, 1993; UNEP, 2002; USEPA, 1998; National Assessment Synthesis Team, 2000; Groat, 2001; Vorosmarty et al., 2001; Environment Canada, 1997; IPCC, 2001b; General Accountability Office, 2003; United Nations Environment Programme, 2005; Smith, 2006; Callaway, 2007).

Subsistence Resources: Arctic resource systems are extensive but also extremely sensitive and, therefore, quite vulnerable to climate change (Berner, 2002). Continuing permafrost thawing and sea-ice melting will continue to threaten important subsistence habitats and species. Increased salinization and coastal erosion from storm surges will produce profound changes to river deltas, often the most productive areas for subsistence hunting and fishing.

Reduced sea ice threatens the survival of polar bears and, because ice now forms later in the fall, bears find it increasingly difficult to reach sea ice to hunt seals and den at the proper time. Reduced sea ice means loss of habitat for other marine mammals, including ringed seals, walruses, and beluga whales; habitat impacts could affect their population numbers and distribution. If the ice edge melts past the continental shelf, walruses will find the water too deep to dive to the seafloor for food, and sea-level rise could inundate marine mammal calving and pupping haulouts. A diminishing ice pack actually might increase the range of certain whales, such as the bowhead; alternatively, this same situation could diminish phytoplankton production, which would lead to declines in key cetacean prey species, such as copepods and plankton-feeding fish that are preferred food for narwhals and beluga whales. A reduced ice pack also could expose whales to increased Arctic ship traffic (Burns, 2000). The timing and sequence of whale migration also may be a function of ice cover and could negatively affect the feeding and reproduction of ice-associated cetaceans, such as bowheads and belugas. Changes to polynyas and ice leads, important in the distribution and migration of bowheads in winter and spring, could have a major impact on bowhead behavior (Huntington and Mymrin, 1996; Lowry, 2000; Parson et al., 2001; NRC, 2003b; USEPA, 1998; National Assessment Synthesis Team, 2000; Environment Canada, 1997; IPCC, 2001b; BESIS Project Office, 1997).

Increasing temperatures will favor the spread of birch forests and reduce important tundra caribou forage. If warming produces increased precipitation, the snowpack may actually increase and spring breakup may be delayed. This delay could change the availability of caribou food sources. Also, a deeper snowpack makes travel and digging through it for forage more difficult. Because female caribou calve at specific times and locations, weather and snowpack changes become added stressors. Observations from Banks Island in Canada's Northwest Territories see caribou migrations changing based on changes in sea ice freeze-up and breakup. Increased temperatures also increase the likelihood of mosquito harassment of caribou. Many populations of seabirds, wildlife, and marine mammals already have been displaced or reduced, and present sea-ice changes have been linked to declining health and birthrates in polar bears (Parson et al., 2001; NRC, 2003b; USEPA, 1998; National Assessment Synthesis Team, 2000; Environment Canada, 1997; IPCC, 2001b; BESIS Project Office, 1997; Russell, 1993; Parmesan and Galbraith, 2004; The Wildlife Society, 2004; United Nations Environment Programme, 2005).

An increase in abundance of deciduous shrubs (less favorable caribou forage), especially birch, and a decline in the abundance of grasses/sedges such as *Eriophorum vaginatum* (an especially important food of calving caribou) would be predicted if a significant increase in average temperature were to occur in the Arctic, an effect that could reduce the productivity of caribou habitats on the Arctic Slope. Over decades, warming temperatures could result in the invasion of tundra habitat by taiga woody plants (taiga forests), a less favorable habitat for tundra mammals and some bird species, thereby adversely affecting their populations and subsistence uses (Anderson and Weller, 1996; USDOJ, BLM, 2004).

With a longer ice-free season, water will warm in Arctic lakes and ponds, leading to possible higher productivity for water life forms. Changes in fish-species composition and productivity in ocean fisheries also could be expected. Global warming may be behind plummeting herring and salmon populations, especially in the Yukon River where a warm water parasite has infected fish; global warming has altered the timing for some

salmon runs and this stresses salmon survival; in other areas of the Arctic, the salmon's range seems to be expanding (Borenstein, 2003; Parson et al., 2001; Callaway, 2007). One study singles out Arctic habitat as the most vulnerable to climate change and estimates that 20% of the existing species could die off by the end of the century due to habitat loss (Lawless, 2000; Schneider, 2001). The Canada Country Study has called these potential climate change impacts "ecosystem shifts outside the limits of historical experience" (Crary, 2002).

If the present rates of climate change continue, changes in diversity and abundance to Arctic flora and fauna are likely to be significant, but at the same time these impacts "cannot be reliably forecast or evaluated" and

positive effects such as extended feeding areas and seasons in higher latitudes, more productive high latitudes, and lower winter mortality may be offset by negative factors that alter established reproductive patterns, breeding habitats, disease vectors, migration routes, and ecosystem relationships (IPCC, 2001b).

Subsistence Practices: Continuing sea ice melting and permafrost thawing will threaten subsistence livelihoods. Typically, Arctic peoples have settled in particular locations because of their proximity to important subsistence food resources and dependable sources of water, shelter, and fuel. Northern peoples and subsistence practices will be stressed to the extent: (1) settlements are threatened by sea ice melt, permafrost loss, and sea-level rise; (2) traditional hunting locations are altered; (3) subsistence travel and access difficulties increase; and (4) as game patterns shift and their seasonal availability changes. Large changes or displacements of resources are likely, leaving little option for subsistence communities: they must quickly adapt or move (Langdon, 1995; Callaway, 1995; NewScientist 2001; Parson et al., 2001; AMAP, 1997, *Anchorage Daily News*, 1997; Weller, Anderson, and Nelson, 1998; IPCC, 2001b). Great decreases or increases in precipitation could affect local village water supplies, shift the migration patterns of land mammals, alter bird breeding and molting areas, affect the distribution and abundance of anadromous and freshwater fish, and limit or alter subsistence access routes (particularly in spring and fall) (AMAP, 1997). Changes in sea ice could have dramatic effects on sea mammal migration routes, and this would, in turn, impact the harvest patterns of coastal subsistence communities and increase the danger of hunting on sea ice (Callaway et al., 1999; Bielawski, 1997). Between 1980 and 2000, three sudden ice events caused Barrow whalers to abandon their spring whaling camps on the ice lead (George et al., 2003; National Assessment Synthesis Team, 2000; Groat, 2001).

Because polar marine and terrestrial animal populations would be particularly vulnerable to changes in sea ice, snow cover, and alterations in habitat and food sources brought on by climate change, rapid and long-term impacts on subsistence resources (availability), subsistence-harvest practices (travel modes and conditions, traditional access routes, traditional seasons and harvest locations), and the traditional diet would be expected (IPCC, 2001b; NRC, 2003b; ACAI 2004).

Climate change and the associated effects of anticipated warming of the climate regime in the Arctic could significantly affect subsistence harvests and uses if warming trends continue (NRC 2003b, ACIA 2004). Every community in the Arctic is potentially affected by the anticipated climactic shift and there is no plan in place for communities to adapt to or mitigate these potential effects. The reduction, regulation, and/or loss of subsistence resources would have severe effects on the subsistence way of life for residents of coastal communities in the Beaufort and Chukchi Seas, including Russian coastal communities in Chukotka. If the loss of permafrost, and conditions beneficial to the maintenance of permafrost, arise as predicted, there could be synergistic cumulative effects on infrastructure, travel, landforms, sea ice, river navigability, habitat, availability of freshwater, and availability of terrestrial mammals, marine mammals, waterfowl and fish, all of which could necessitate relocating communities or their populations, shifting the populations to places with better subsistence hunting, and causing a loss or dispersal of community (NRC 2003b, ACIA 2004; USDOI, BLM, 2005; Parmesan and Galbraith, 2004; The Wildlife Society, 2004; United Nations Environment Programme, 2005; Callaway, 2007).

V.C.12.f(6) Traditional Knowledge on Arctic Climate Change.

Russia: Chukchi Natives from Chukotka have experienced for the first time in memory the Chukchi Sea being ice free in winter. Others have seen the tundra dry up and reindeer starve; they have cut open salmon and found unknown insects inside. Willows have begun to grow in places they never did before. Fresh gray whale meat smells rancid "like medicine" and sled dogs refuse to eat it (McFarling, 2002).

Canada: Observations by Canadian subsistence hunters and biologists of skinnier, weaker seal pups are presumed to be related to temperature and timing of ice melt (Tynan and DeMaster, 1997). Canadian Natives on Banks Island, Northwest Territories, report that travel for hunting has already become more difficult because of melting permafrost and its effects on terrain (Raygorodetsky et al., 1997).

Freezing rain and less snow in spring also have made hunting more difficult. Hunters speculate that changes in cloud conditions are affecting visibility and hunting ability. Thinner sea ice means impeded access and increased danger to those hunting or whaling offshore; yet thinner, later forming, and earlier melting sea ice also expands the season for open-water hunting (Freeman, 1994; Hom, 1995). There are documented cases of cetacean range changes related to temperatures in 1980's, and recent Native observations of distribution changes of killer whales, bowheads, belugas, narwhals, and bearded and ringed seals thought to be related to climate change (Northern Climate Exchange, 2003).

Canadian Inuit have observed the impacts of thinner ice on moose travel and survival, and other Natives have noted that species such as mule and white-tailed deer, elk and cougar are expanding their range northward in the Yukon (Tynan and DeMaster, 1997; York, 1995). Banks Island Natives attest to muskoxen being born earlier and polar bears coming out of dens earlier and believe this behavior is because of an earlier onset of spring. Data from Banks Island, Northwest Territories indicates that changes in timing of sea ice freezeup and breakup are interfering with annual caribou migrations (Raygorodetsky et al., 1997). Long-term data set using information from hunters in the Mackenzie River District (1970-1991) correlates spring melt with breeding success of geese (Marouf and Boyd, 1997). In Nunavut, Canada, the Inuit have begun to call the weather "uggianaqtug"—like a familiar friend acting strangely (McFarling, 2002).

Sheila Watt-Cloutier, president of the Inuit Circumpolar Conference, lives on Baffin Island in Canada's high Arctic. She observed: "the ice is thinning and people are falling through it." She has seen Inuit families find themselves bogged down in mud from melting permafrost following early thaws. Sea ice is breaking up earlier and seals are harder to reach for hunters and bears. Watt-Cloutier observes: "A threat to our country food isn't just a threat to our health and well-being; it's a threat to our cultural survival" (Armstrong, 2003).

Observation from Peter Ernerk from Rankin Inlet, NWT relates:

The sun seems to be stronger than it used to be, especially this past spring when I noticed its strength during my big circle travel by snowmobile from Rankin Inlet to Baker Lake, Gjoa Haven, Spence Bay, Pelly, Repulse, Chesterfield Inlet and return. Lypsal [lip protection] didn't seem to have its usual strength.... (Ernerk, 1994).

Norma Kassi, of the Vunut Gwich'in people from Old Crow in the Yukon Territory, reflects their dependence on the Porcupine caribou herd:

People are directly affected by global climate change...there are no compromises we can make. There are no changes we can make in these old ways. We cannot be compensated for any damages that might occur to our land, the birds, animals, water, fish... We have no alternatives to our way of life. This is the only one we know. Without this way of life, we will disappear... (Kassi, 1993).

Rosemarie Kuptana, an Inuit from Sachs Harbour, states: "We've had hunters fall through the ice because it looks different from what our parents taught us" (Jaimet, 2000). She continues: "We don't know when to travel on the ice and our food sources are getting further and further away... Our way of life is being permanently altered... We now have sand flies here for the first time." New species of birds, including robins and barn swallows, also have been spotted and bird behavior is changing, she says. Snow geese stay for a shorter time in the spring, while some small birds which traditionally migrated, now stay the entire winter (Knight, 2000).

John Lucas, Sr., also from Sachs Harbour related:

Never saw salmon here before. People here have been setting nets for quite a while. That is the first time I ever seen that. Even herring [least Cisco] for that matter. It is kind of changing around here for us. I really find a difference with the fish that they are catching. Chars are getting bigger then we used to catch (Jolly et al., 2002).

Naalak Nappalak, an elder from Kangiqsujuaq in Canada's Arctic talks about fluctuations in the weather and temperature: "Before we knew by looking at the sky whether there would be storms or if it would be calm.... Nowadays just when you think you know how the weather will be, they can change in an instant.... (Nelson, 2003).

Alaska: In Alaska, more humpback whales have been seen at Gambell in the Bering Sea; bowhead whales have been seen near Deering in Kotzebue Sound and fewer bearded seals are seen there; populations of some bird species (e.g., oldsquaws, sandpipers) have declined in some areas; multiyear ice floes no longer drift south through the Bering Strait to St. Lawrence Island in the fall. At Barrow, the break up of sea ice is much earlier than it used to be, occurring now in June rather than July; seawater freezes only from the top rather than also on the bottom as it used to. (Bottom-forming ice brings sediments and nutrients to the surface when it breaks free and floats.) Physical effects also have been observed: sandy beaches are disappearing on St. Lawrence Island as erosion increases, because there are more storms and less sea ice to protect shorelines in the fall (Huntington, 2000).

Inupiat in Barrow have had ice cellars drip water for the first time in memory and in Kaktovik, a robin built its nest in town in 2003; there is no word in the Inupiat language for robins). Along the Okpilak River (Okpilak means river with no willows) is now crowded with willows. Salmon are arriving to Kaktovik where there were almost no salmon a generation ago. Ninety-two-year-old Nora Agiak observes: "The weather is different, really different.... We're not getting as many icebergs as we used to. Maybe the world moved, because it's getting warmer." (AMAP, 1997; Groat, 2001; Kristof, 2003).

In Barrow, Eugene Brower, President of the Barrow Whaling Captains Association related: "Last year the ice went over the horizon and stayed over the horizon all summer. We would have to go over 20 or 30 miles just to hunt seals" (Talbot, 2000). In June 2000, Barrow experienced its first thunderstorm ever (Lowry, 2001).

Usually, bowhead hunting begins in early April, but one Wainwright elder noted that the bowheads are "slowing down" and have not been appearing until late April, or even May. Over the past few years, residents have noted that on furbearing animals, specifically the wolverine, the fur is not as thick as it used to be. This change is attributed to unusually warm fall and winter seasons. In recent years, late sea-ice formation has left many polar bears trapped on land. Unable to venture out onto ice in search of seals, many polar bears appear to be starving (Kassam, K-A.S. and Traditional Council, 2001).

The ongoing "Human and Chemical Ecology of Arctic Pathways by Marine Pollutants" collaborative project between the Wainwright Traditional Council and University of Calgary researchers that produced the report entitled *Passing on the Knowledge: Mapping Human Ecology in Wainwright, Alaska* revealed a number of observations by local hunters concerning changes in subsistence resource behaviors and populations. Community members noted changes in the skin color of beluga whales "from the normal white to a yellowish tinge." Changes in ice conditions have produced major changes to polar bear behavior. In recent years, the late formation of sea ice "has left many bears trapped on the land." Because they are not able to reach the ice and hunt for seals, many polar bears appear to be starving. Caribou migration corridors also have changed. In the last 50 years, local hunters report that more caribou are staying closer to the community rather than following the herd on its migration. Shorter, thinner fur on small furbearers has been reported, especially wolverine. Villagers attribute this change to unusually warm fall and winter seasons. Hunters have reported that "birds harvested in the fall have enlarged livers and gizzards and white (rather than yellow) fat." A number of changes to fish have been observed. A greater number of salmon and a greater number of salmon types have been reported. Fewer fish are reported when boats travel the rivers, and more fish have been found with open sores. Finally, mature grayling seem to be smaller than in the past (Kassam and the Wainwright Traditional Council, 2001).

Charlie Tuckfield, Sr. from Point Lay relates: "A lot of moose come here this summer [1997]. That's kind of unusual. The last few years, they've been coming in. I never saw moose in my lifetime until the last couple of years" (Gibson and Schullinger, 1998).

In the Chukchi Sea, hunting camps on the ice for whales and bearded seals often are several miles offshore, close to preferred habitat, and the more frequently used migratory pathways. Poor ice conditions and/or leads closer to shore can greatly increase the risk of travel on the ice and can reduce or stop access to those offshore

hunting areas. Hunters along the southeastern Chukchi Sea coast and elsewhere along the Arctic Ocean sometimes attribute poor hunting success to poor ice conditions. Some of the people who live and hunt in the Chukchi Sea and are intimately familiar with the ice conditions there are convinced that climate changes in the last few decades have caused thinner ice, earlier breakups, and poorer hunting conditions. Any fixed structures, including natural shoals, islands, and man-made structures can contribute to lead formation in moving ice (U.S. Army Corps of Engineers, 2005).

Hannah Mendenhall from Kotzebue stated:

The thing that I notice when I walk out on the tundra--now I can hear it crackle when I walk on it, and it's dry. Whatever is out there is dried up. We didn't get blueberries this year, last year, and the year before. I used to be able to find blackberries in abundance, and now I have to really search (<http://arcticcircle.uconn.edu/NatResources/Globalchange/globalindex.html>).

Hunter and elder, Caleb Pungowiyi, from Kotzebue reflects:

We see our hunters taking chances by going out in weather conditions that put their lives at risk. There are economic costs as the hunters travel greater distances to harvest game, expending more fuel and time. There are times when hunters will return empty-handed because the game was not there or out of reach.... We are resilient people, and we adjust quite readily to change, but if that change is too rapid, too disruptive, it will cause social chaos, hardship, and suffering (Schneider, 2001).

He continues: "When the earth starts to be destroyed, we feel it" (McFarling, 2002).

In another interview Pungowiyi stated:

There's plenty of animals out there now. The problem is accessibility. If the ice is further away, we have to go further. Our access to them, our ability to harvest them, and our success rate is being affected. There is a potential for hardship. If the sea ice continues to retreat further and further north, villages that used to depend on marine mammals will see their lives turned around and they'll have to rely on something else (Arctic Science Journeys, 2001).

Roswell Lincoln Schaeffer, Sr. also from Kotzebue said that:

The changes that we've seen these last few years are that it's been very warm in the winter time. We do have exceptions. Say, three or four years ago, we had our fall start in September, and winter occurred September 15th. We had a real early freeze.... Generally, I think our temperatures have really warmed up (Gibson and Schullinger, 1998).

Pete Schaeffer from Kotzebue observes:

Winter storms seem to be much more violent, than what I recall as typical. For example, about four years ago we had a western blizzard that was kind of like a wall of weather that showed up...it went from zero to about 65 miles an hour in ten minutes. That was really unusual I guess. I think the severity of the wind has picked up in the last twenty years. I think that sort of poses, along with thinner ice and different snow conditions, another set of circumstances weather wise, to have to get accustomed to than what we had to deal with in the past (Gibson and Schullinger, 1998).

Gilbert Barr from Deering remarks:

It seems to me that winters are not as cold as they used to be. Maybe that's due to the lack of precipitation. I've been involved with the City Council off and on for the last twenty or so years, and guess a good indication would be our financial report for the public road maintenance that we do. Normally that program was always running into the red because of snow removal. For the last couple of years—and I don't know if this is good or bad—we've been operating in the black. It's good for the finances of the city, but not for hunting. Last year there were more caribou than I've ever seen or heard of in my life here, but the guys couldn't go out hunting due to lack of snow. I guess it probably could be done, if you wanted to really hurt your snowmachine. But you'd have to weigh whether the cost of

parts for your snowmachine would be worth the effort of getting the caribou while they're this close to us (Gibson and Schullinger, 1998).

Also from Deering, Gibson Moto mentions:

It's harder to hunt for some sea mammals that can't get on the ice. For some odd reason, the ugruks that we hunt are further out there. There's lots of clean ice and there's no ugruks or seals on it. Maybe because of the walrus coming around. Hundreds of walrus. They kill the ugruks and the seals (Gibson and Schullinger, 1998). In Shishmaref, Esther Iyatunguk remarks in relation to the erosion happening there: "The ocean is eating our land." Robert Iyatunguk continues: "Our winter storms have been more frequent. We expect them in November but they're coming in October" (Schneider, 2001).

Stanley Oxereok from Wales relates:

The ice used to be five-six feet thick. The last couple of years it's been four, four and a half feet. That's a foot, a foot and a half, and that's a pretty substantial difference.... One year we were hunting in our boats in January. We've never done that before. It was the first time I could remember in my life seeing us boating in January when the water is usually frozen. Break up seems to come quicker. Sometimes a couple of weeks, sometimes as much as a month sooner.... Freeze up was as much as a month late (Gibson and Schullinger, 1998).

In a series of interviews made with Native Whalers in Gambell, Wales, Point Hope, Wainwright, and Kaktovik in 2000-2001, climate change and global warming emerged as a major concern in all villages as potential cause for the changes they had seen in sea ice, weather patterns, and sea mammal distributions. Whalers in Kaktovik voiced a concern about global warming impacts on krill production (Harritt, 2001).

In Savoonga, according to John Kulowiyi, Sr., an Elder and whaling captain: "When I was younger, we used to go out on the ice. It was real solid. But as the years go by, the ice started getting thinner and thinner."

He continued:

I was at camp about six years ago, I guess. There is a camp named after my last name, Camp Kulowiyi. One day I went fishing with my fish net and my boys and my grandkids and we caught some kind of strange fish right there. We usually get trout, river trout and here we see chum salmon, king salmon and humpbacks, humpys. That's strange for us. We never used to get those around here. I don't know why they are coming here but it must be the warming climate (Gibson and Schullinger, 1998).

Jerry Wongittilin, Sr., also from Savoonga, observed:

There have been a lot of changes in the sea ice currents and the weather. Solid ice has disappeared, and there are no longer huge icebergs during fall and winter. The ice now comes later and goes out earlier, and it is getting thinner. The current is stronger, and it is windier on the island. We had a bad hunting season with lots of high winds. Our elders tell us that our earth is getting old and needs to be replaced by a new one (Craver, 2001). In recent years Yup'ik hunters have noticed that winters are warmer, walrus are looking thinner, and their blubber is less nutritious; they have to go further from shore to find the ice pack where they hunt seals (National Assessment Synthesis Team, 2000).

Tom Kasayulie, an elder from Akiachak, noted that there is less water from rain and snow on the tundra now and this has caused lakes to dry out...and: "The warmer weather and higher temperatures are ruining the fish drying on fish racks. We catch less salmon in the river...." (Bradley, 2002).

Edward Shavings from the village of Mekoryuk on Nunivak Island related:

I have seen changes taking place today. About two years ago a lot of murrees were dying out there. They would get very weak, swim very slowly. A lot of them were dead; I don't know the cause of their dying off—probably a shortage of food. There have been changes in the weather. In the spring the ice and snow is starting to melt very fast. We used to get very thick ocean ice, but I believe the

area is getting warm. We seem to have long sun or daylight hours that melt the snow and the ice to the bottom; and we have early break-ups now (Mercurieff, 2002).

Athabaskan elder, Jonathon Solomon, speaking at the Alaska Native Fish, Wildlife, Habitat, and Environment Summit in Anchorage in 2002 declared:

I have seen changes in my homeland in the Yukon Flats. Our rivers are so low that people can't fish. There are lakes that are going dry; the permafrost is melting—there's no more fish. We're lucky to see ten caribou at one time (Mercurieff, 2002).

Dune Lannkard, of the Eyak preservation Council remarked:

We have not had very much snow for the last decade. Lots of precipitation. The ocean currents have become warmer, lots of interesting changes in the ocean. Last but not least, the glaciers have been receding and melting at an alarming rate (Alaska Native Oil and Gas Working Group, 2003).

Conclusion. Cumulative effects on subsistence-harvest patterns include effects from Alternative I for Sale 193 exploration, development, and production and other past, present, and reasonably foreseeable projects on the North Slope could cause 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 noise and traffic disturbance, disturbance from construction activities associated with ice roads, production facilities, pipelines, gravel mining, supply efforts, and potential oil spills.

Cumulative Effects to Subsistence. Oil and gas development could inhibit subsistence harvesters' use of traditional harvest areas, which could reduce harvest success; increase the cost, effort, and risk involved with subsistence harvest; increase the and wear and tear on equipment used for harvesting subsistence foods; devalue elders' knowledge of the traditional landscape; increase the importance of local knowledge of oil industry schedules and practices; and reduce the enjoyment of eating traditional foods, should harvests be reduced or perceptions of contamination of subsistence resources arise.

The communities of Barrow, Wainwright, Point Lay, Point Hope, and Kivalina and Chukchi coastal communities in the Russian Arctic potentially would be most affected, with Wainwright potentially being the most affected community because of potential impacts from shore-base-facility construction. In the 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. The placement of a drilling structure near the bowhead whale migration corridor that operated over the life of a field (15-20 years) would be another likely source of significant impacts 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.

Because polar marine and terrestrial animal populations would be particularly vulnerable to changes in sea ice, snow cover, and alterations in habitat and food sources brought on by climate change, rapid and long-term impacts on subsistence resources (availability), subsistence-harvest practices (travel modes and conditions, traditional access routes, traditional seasons and harvest locations), and the traditional diet would be expected (IPCC, 2001b; NRC, 2003b; ACIA, 2004; Millennium Ecosystems Assessment, 2005; United Nations Environment Programme, 2005; Callaway, 2007).

Contribution of Alternative I to Cumulative Impacts. Alternative I for Sale 193 represents a small proportion (6-15%) of the total past, present, and reasonably foreseeable oil and gas development on the North Slope and in the Beaufort and Chukchi seas. While the most likely number of oil spills ≥ 500 bbl from all past, present, and future activities onshore is estimated to be nine, the most likely number of offshore spills is estimated to be five. Alternative I for Sale 193 is estimated to contribute about 10% of the estimated mean number of cumulative offshore spills, with a most likely number of spills of 0.

In the event of a spill from Alternative I for Sale 193, 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 and beluga whales and other marine mammals 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 and other marine mammal 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.13. Sociocultural Systems.

The cumulative effects on sociocultural systems include effects to social organization, cultural values, and institutional organization from:

- Lease Sale 193 described in section IV.C.1.m.
- Exploration from activities associated with additional sales in the 5-year OCS oil and gas leasing program and planned oil and gas sales in the NPR-A.
- Other ongoing or planned projects on the North Slope that would include exploration and development and production activities associated with existing leases.

Contribution of Alternative I to Cumulative Impacts. The cumulative effects of oil and gas development and other activities on sociocultural systems are largely the same as those of recent analyses, except the area over which the effects could be realized will now encompass portions of the Chukchi Sea coast, particularly Wainwright. On the regional level, cumulative effects from oil and gas development and other activities would have direct and indirect consequences on social organization, cultural practices and institutional organization but would not tend to displace social systems. The Proposed Action would represent a small percentage of the foreseeable cumulative activities.

V.C.13.a. Results from Previous Effects Analysis.

The cumulative effects of oil and gas development and other activities on sociocultural systems (social organization, cultural values, and institutional organization) have been described in a number of recent environmental impact statements (USDOJ, MMS, Herndon, 2002; USDOJ, BLM, 2004, 2005; USDOJ, BLM and MMS, 2003; USDOJ, MMS, 2003a, 2004, 2006a,c). The extent of the effects described by these analyses includes:

- Adaptation to introduction of new technology, pressures, and legal/regulatory actions introduced through successive waves of contact between Natives and non-Natives starting with whaling in the 19th century through oil and gas development in the 21st century.
- Change in settlement patterns with greater centralization into larger communities.
- Continuation of pattern of centralized leadership of whaling captains and their families, cultural and nutritional dependence on subsistence foods, reliance on sharing and kinship, connection to family camps and traditional use areas, and a desire to control destination of their communities.
- Stress to sociocultural systems that result from the encroachment of oil-production facilities into areas used for subsistence, although the cumulative effects of the relationship is difficult to precisely measure quantitatively because of lack of baseline data.
- Population growth and employment and an influx of non-Native workers can cause long-term disruption to social organization and place increased demands on institutions that provide public service and health care.
- Problems North Slope communities are experiencing in social health and well being and that could be exacerbated by additional development.
- Stress created by fear of an oil spill, a predevelopment impact-producing agent that is distinct from potential effects from routine operations.
- Response of institutions to strengthen Inupiat traditions and culture in the face of these stresses.
- Positive effects from higher income and community infrastructure and services made possible from oil and gas activity.
- Effects from an oil spill that would be essentially identical to the effects described in Section IV.B.1.m(4)(b) on Chukchi Sea+ and other NSB communities.
- Transportation effects from large tanker spills along the TAPS tanker route, which would cause severe stress and disruption to the social organization, cultural values, and institutional organization to the affected areas and communities, such as Cordova.

- Recent statistics on homicides, rapes, and wife and child abuse, present a sobering picture of some aspects of life in North Slope Borough communities. Problems with domestic violence, suicide, child abuse, birth defects, accidents, sexual assaults, homicide, and mental illness are attributed to alcohol and drug abuse. Oil and gas development has provided funding for a range of social services for North Slope Borough residents. Oil development has been a factor in adverse health effects by contributing to stress and anxiety about subsistence. Disruption of traditional social systems and subsistence practices has coincided with increased incidence of cancer, diabetes, and other social problems. Cancer and asthma rates have been identified as major health problems, variously attributed to smog and haze or to the effects of primary and second-hand smoke.

V.C.13.b. Institutional Organization Capacity.

As noted in Section IV.C.1.m, industrial activities create the opportunity for institutions to participate in the planning process for the project at the local, State, and Federal level. These organizations bear the marginal costs of doing so. Depending on the location, number, magnitude, and timing of development projects, the cumulative effect could challenge and possibly exceed the capacity of some organizations to effectively participate in the process. The timing of activities and the resources available to any given organization through the institutional network should minimize this potential effect.

V.C.13.c. North Slope Borough Revenues.

The declines in projected NSB-assessed values because of capital depreciation of petroleum infrastructure and the resulting property tax revenue are expected to continue, at least in the short term. For example, from 2006-2009, NSB-assessed valuation is projected to decline from approximately \$8 billion to \$6 billion, while property tax revenue are projected to decline from \$150 million to \$120 million. Other sources of revenue to the Borough are not expected to compensate for the decline. As newer and more efficient types of development come on line and as older methods and facilities are phased out, the tax base of the NSB could decline further. Future assessed values could be higher depending on development of potential projects, such as Liberty and the Alaska Natural Gas Pipeline, and the assessed value of the new infrastructure associated with the projects (Northern Economics, Inc., 2006). The value of these facilities would help to moderate the corresponding decline in NSB expenditures for the range of services it provides to communities.

V.C.14. Archaeological Resources.

The greatest cumulative effect on archaeological resources in the Chukchi Sea Sale 193 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.

Ocean-bottom-cable seismic surveys potentially could impact both prehistoric and historic archaeological resources in waters inshore of the 20-m isobath or in deeper water, if cables are laid from shallow to deep water. Such offshore seismic-exploration activities could disturb these resources and their in situ context. Assuming compliance with existing Federal, State, and local archaeological regulations and policies and the application of MMS' Geological and Geophysical (G&G) Permit Stipulation 6 (regarding the discovery of archaeological resources) and CFR 251.6(a)(5) regarding G&G Explorations of the Outer Continental Shelf to not "disturb archaeological resources," most impacts to archaeological resources in shallow offshore waters of the Chukchi Sea Proposed Action area would be avoided. Therefore, no impacts or only minor impacts to archaeological resources are anticipated; cumulatively, proposed projects are not likely to disturb the seafloor.

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* oil spill (EVOS), 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, mitigation 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.

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 EVOS indicate that <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 EVOS, 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 EVOS 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 Transportation Activities on Archaeological Resources. In addition to Alternative I for Sale 193, other activities associated with this cumulative analysis that may affect archaeological resources in the Chukchi Sea include lease sales and activity in the Beaufort Sea and the NPR-A 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, 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 to Cumulative Effects: The contribution of Alternative I for Sale 193 to the cumulative case is expected to be minimal for archaeological resources. 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 193 would be additive to effects anticipated for other future projects and, in the case of oil spills, is uncertain. However, data from the EVOS indicate that <3% of the resources within a spill area would be significantly affected.

Under the cumulative scenario, the impact to both prehistoric and historic archaeological sites should be negligible. The incremental contribution of the Proposed Action to the cumulative impacts on archaeological resources should be negligible.

V.C.15. Environmental Justice.

Alaska Inupiat Natives, a recognized minority, are the predominant residents of Chukchi Sea coastal communities in the Northwest Arctic Borough (NWAB), the area potentially most affected by Alternative I for Sale 193 exploration, development, and production activities. 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, Wainwright, Point Lay, Point Hope, Kivalina, and subsistence communities on the Russian Chukchi Sea coast. For a detailed discussion of Environmental Justice effects, see Section IV.C.1.p and the cumulative-effects analyses for subsistence harvest patterns and sociocultural systems in Sections V.C.12 and V.C.13.

Sources that could affect subsistence resources include potential increased seismic-survey activity, 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, Atkasuk, Nuiqsut, and Kaktovik potentially would be most affected, with Nuiqsut potentially being the most affected community, because it is within an expanding area of oil exploration and development onshore (Alpine, Alpine Satellite, Northeast and Northwest NPR-A, the Red Dog Mine, and the DeLong Port Facility expansion); nearshore (Oooguruk and Nikaichug field developments); and offshore (Northstar, the proposed Liberty project, increased seismic-exploration activity, potential drilling operations off Kaktovik, and Canadian drilling off the McKenzie River Delta).

In the event of a large spill, 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. 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. One or more important subsistence resources would become unavailable or undesirable for use for 1-2 years, a significant adverse effect. 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 increased individualism, wage labor and entrepreneurship. Long-term effects on subsistence-harvest patterns also could be expected.

V.C.15.a. Additional Aspects of Environmental Justice Cumulative Impacts.

Non-oil and gas development associated with military, residential, and commercial development have directly impacted several thousand acres of fish and wildlife habitat and have also indirectly affected habitat and animal behavior effects that have accumulated and persist today. During the mid-20th Century, the Department of Defense contracted for the construction of DEW-line and WACS sites on the North Slope. During and after construction of these facilities indigenous residents could no longer hunt near these sites that, in most cases, were sited on or near important subsistence and traditional sites. Operation of these facilities by the military, and later by contractors, resulted in contamination of the surrounding area with fuel, oil, antifreeze, and other chemicals, leading to further avoidance of these sites by subsistence harvesters concerned about subsistence food contamination. Postwar oil exploration produced additive impacts on subsistence resources, harvest patterns, and users. These activities cumulatively resulted in the loss of approximately 2,500 acres of habitat for subsistence species (USDOJ, BLM, 2005).

The most intense oil and gas development activity occurred during the 1970's and early 1980's with the development of the Prudhoe Bay and Kuparuk oil fields, the construction of TAPS, the haul road, and the construction of a large portion of the roads, drilling pads, gravel sources, collector pipelines, and regional production facilities. This activity has resulted in the cumulative direct loss and indirect loss of approximately 13,000 acres and 21,000 acres of habitat, respectively, for subsistence species, and higher levels of disturbance that can impact species health, reproduction, and survivorship. Subsistence practices also were impacted (USDOJ, BLM, 2005).

North Slope subsistence users have noted the decline of fish populations from onshore seismic survey activities, the diversion of caribou from traditional migration routes and calving areas from increased low-flying aircraft

traffic, the disruption of caribou movements by low pipelines, and the displacement from traditional harvest areas because of hunter avoidance of industrial areas. Oil and gas development in the Prudhoe Bay and Kuparuk areas affects subsistence harvests by causing subsistence hunters to avoid certain areas because of concerns about firearm safety, and specifically has discouraged Nuiqsut residents from using the eastern portions of their traditional harvest areas (USDOI, BLM, 2005).

Impacts to subsistence caused by seismic exploration programs have also been observed for many years. Although seismic testing no longer uses dynamite on fish bearing lakes, Iñupiat blame this activity for historic declines in fish numbers in the many interconnected lakes and streams used by subsistence fishermen. Arnold Brower, Jr. stated in scoping testimony for the 1998 Northeast NPR-A assessment process a consensus opinion among Inupiat subsistence hunters that seismic testing, even in its current refined form, deflects subsistence animals from the areas it operates in (USDOI, BLM, 2005).

Although the North Slope and the northwest Arctic still has huge areas that are relatively undisturbed, the general subsistence-hunting environment continues to change in response to increased development. The continuing expansion of oil exploration and development activity to the west of Prudhoe Bay effectively would enlarge the area considered off-limits by subsistence resource users, potentially deflecting important subsistence resources from their normal routes, and require users to travel farther to harvest subsistence foods (Impact Assessment, Inc., 1990a). The ever increasing size of the developed area for oil and gas activities would reduce the area suitable for North Slope and northwest Arctic subsistence users to harvest necessary subsistence resources (USDOI, BLM, 2005).

Oil and gas exploration and development have had direct impacts on the habitat use and behavior of subsistence species and potentially disrupted subsistence livelihoods. The Iñupiaq people will continue to be affected by future disturbances to key subsistence species that can lead to disruption, displacement, or long-term changes in species' populations. Expanded oil and gas development on- and offshore on both Federal and State leases would increase disturbance effects to subsistence species and harvest patterns. While individual projects likely contribute small incremental increases, the additive cumulative effect of this collection of discrete projects likely will become ever more repressive to the subsistence lifestyle. Five-thousand or more acres could be directly impacted from oil and gas development associated with future activities in NPR-A and elsewhere on the North Slope. Indirect impacts to soil, water, and vegetation could be three to four times the amount of direct disturbance (USDOI, BLM, 2005).

Transportation facilities and activities also would contribute to cumulative effects to subsistence resources and, consequently, to the Native population. A new permanent road connection from TAPS to Nuiqsut and the NPR-A would facilitate petroleum development and would provide a travel route for the public to this region of the North Slope. A road would encourage more hunters and other visitors to travel to the region and increase the potential for conflicts between subsistence and nonsubsistence users of fish and wildlife resources. It is acknowledged that cumulative sociocultural impacts have occurred on the North Slope and that Iñupiaq culture has undergone noticeable changes (USDOI, BLM, 2005).

At the same time, revenues from NSB taxation on oil development have produced positive cumulative impacts that include increased funding for infrastructure, higher incomes (that can be used to purchase better equipment for subsistence), better health care, and improved educational facilities. For communities like Nuiqsut that are relatively close to oil-development activities on the North Slope, cumulative effects chronically could disrupt sociocultural systems in the community. Wainwright, in the long term, could experience similar impacts.

The MMS acknowledges sociocultural cumulative impacts on the North Slope and that Inupiat culture has undergone significant change (see Sec. IV.C.13, 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 and produced other changes in the Inupiat culture. The sources of cumulative effects are difficult to disaggregate 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. Causal linkages to impacts on subsistence resources and practices, and Inupiaq social systems from on- and offshore sources will continue to be problematic, and even with improved monitoring regimes, these linkages will be difficult to establish.

V.C.15.b. Mitigating Initiatives Related to Environmental Justice Cumulative Impacts.

In-place protective mitigation, stipulated measures for seismic-survey permits, and mitigation accompanying NMFS IHA authorizations (that ensures Conflict Avoidance Agreements will be in place) ensure that acceptable levels of whale monitoring will occur and that no unmitigable adverse effects to subsistence-harvest patterns, resources, or practices and any consequent impacts on sociocultural systems would occur from noise and disturbance.

For a more detailed discussion of standard and proposed mitigation measures, ongoing and proposed studies, and other mitigating initiatives that relate to environmental justice concerns and that hopefully will contribute to a more comprehensive understanding of cumulative impacts on the Native population of the North Slope and the northwest Arctic, see Section IV.B.1.1.

Other efforts to address cumulative impacts include a November 2001 meeting of the MMS OCS Policy Committee where they discussed the need for the Department of the Interior to find 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 stresses 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 all EIS analyses since the Liberty final EIS in May 2002.

The MMS, in conjunction with the NSB 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.

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 NMFS and the AEWC 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 ongoing *Sociocultural Consequences of Alaska OCS Activities: Data Analysis/Integration* study is a cooperative agreement with the Alaska Department of Fish and Game, Subsistence Division to analyze and integrate subsistence, socioeconomic, and sociocultural time-series data from previous MMS-sponsored projects in order to assess the occurrence and implications of sociocultural change from OCS activities.

The National Academy of Sciences conducted a multiyear *Cumulative Environmental Effects of Alaskan North Slope Oil and Gas Activities Study*, under the direction of Dr. David Policansky. The committee of national, State, and local experts reviewed information about oil and gas activities (including exploration, development, and production) on Alaska's North Slope. Based on the review, the committee assessed the known and probable

cumulative impacts of oil and gas activities from the early 1900's to the present (including cleanup efforts) on the physical, biological, and human environments of Alaska's North Slope (including the adjacent marine environment). It provided an assessment of potential future cumulative effects, based on likely changes in technology and the environment and a variety of scenarios of oil and gas production—all in combination with other human activities, including tourism, fishing, and mining. The committee described and documented its methodology for assessing cumulative effects and identified gaps in knowledge and made recommendations for future research needed to fill those gaps. The MMS and other Federal and State agencies conducting oil activities on the North Slope are working to implement the recommendations of this study that specifically advocates for "a slope-wide, jurisdictionally coordinated framework for wildland evaluation, mapping, ranking, impact analysis, and planning [that] would help decision-makers identify conflicts, set priorities, and make better-informed decisions" (NRC, 2003b).

Specific research needs and approaches identified by the NRC study include: (1) targeting how much oil and gas activities are associated with rising levels of sociocultural change; (2) conducting more culturally and locally cooperative research by incorporating more traditional and local knowledge into research study designs; (3) focusing on translating theoretical research "concepts and values into concrete terms" that can better be used in environmental assessment; and (4) better identifying the physical, psychological, cultural, spiritual, and social human-health effects of oil and gas development on North Slope residents (NRC, 2003b).

More recent ongoing and proposed research and sovereignty initiatives regarding cumulative impacts to the indigenous populations in the Arctic and Native populations on the North Slope include:

- the Second International Conference on Arctic Research Planning (ICARP-2) that met in April 2005 to develop a plan to study the resilience and vulnerability of rapid change to local communities in the Arctic;
- a U.S. Census Bureau report *We the People: American Indians and Alaska Natives in the United States* that provides a portrait of the demographic, social, and economic characteristics collected from Census 2000 of indigenous American populations and discusses specific tribal groupings, reservations, and Alaskan Native village statistical areas;
- *Food Security in Arctic Alaska: A Preliminary Assessment* (Caulfield, 2000) that advocates for a better understanding of subsistence food security, more up-to-date research to determine country foods types, pricing, transportation systems, and a better understanding of relevant laws, policies, and controlling institutions;
- *Human and Chemical Ecology of Arctic Pathways by Marine Pollutants* study (O'Hara et al., 2002) that will document reliance by indigenous arctic marine communities in Canada, Alaska, and Russia on arctic resources at risk from chemical pollutants and incorporate traditional knowledge systems for harvesting;
- the *Arctic Human Development Report* developed by the Arctic Council in 2005 to provide an overview of human development in the Arctic, identify critical data gaps, establish priorities for sustainable development, and shed light on the dimensions of human well-being in the region;
- *Vital Arctic Graphics Report* (UNEP, 2006) that identifies critical Arctic ecosystems to protect important indigenous regions and food sources to ensure sustainable development in the region; and
- a subsistence foods study *The Contribution of Subsistence Foods to the Total Diet of Alaska Natives in 13 Rural Communities* funded by the Agency for Toxic Substances and Disease Registry conducted by Ballew et al. Researchers confirmed, as many other studies have before, that subsistence foods make up a large part of the total Alaska Native diet. They quantified subsistence food intake and set the stage for the long-term goal of the study which is to evaluate the health benefits and risks of consuming subsistence foods so as to allow people to make more informed food choices. They were unable to quantify the economic balance of subsistence and purchased foods. They reiterated that the data to assess exposure to contaminants in subsistence foods were inadequate because many traditional foods have yet to be tested. They concluded that testing of the foods that people consume most should be the highest research priority (Ballew et al., 2006).

Since 2003, MMS has funded the Nuiqsut-based study *Analysis of Variation in Abundance of Arctic Cisco in the Colville River*, which sponsored a local workshop in Nuiqsut for Traditional and Western science experts on arctic cisco to answer questions about arctic cisco abundance. The proceedings of this workshop were published in the USDOJ, MMS, 2004b). Separate Traditional Knowledge and Western science reports will be final products of this study.

Indigenous initiatives to address Arctic issues include the formation of an alliance of grass-roots Native activists called Resisting Environmental Devastation on Indigenous Lands (REDOIL) to confront oil and gas development issues in Alaska. This alliance condemns extractive industries and the Alaska Native Claims Settlement Act (ANCSA) and has come together to address aboriginal, economic, and Environmental Justice issues concerning the role of corporations, the State of Alaska, and the Federal Government in oil and gas development (Dobbyn, 2003). In April 2006, the Indigenous Peoples and Nations Coalition sent a petition to the United Nations challenging U.S. title to Alaska and Hawaiian Native lands, referring the situation to the proper United Nations agencies, “so that the rights of the Indigenous Peoples can be vindicated, including the right to self-government and to enjoyment of their natural resources” (AITC, 2006).

Local governments and stakeholders have encourage the development of a standing interagency-intergovernmental working group that would include local and regional North Slope and northwest Arctic 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. Their scoping comments suggest that 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.

The formation of the North Slope Science Initiative Science (NSSI) Technical Group in February 2006 bodes well for addressing these local concerns and for developing better protocols for assessing cumulative impacts on Alaska’s North Slope. This 15-member group, composed of Federal, State, local, and industry leadership, is tasked with developing a consistent scientific approach to North Slope research and is the most likely group to develop and implement research, monitoring, and mitigation regimes that will address community impacts from North Slope-wide oil exploration and development (*Petroleum News*, 2006).

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 do provide processes for information sharing and opportunities for mutual decisionmaking and remediation of cumulative social and subsistence impacts.

V.C.15.c. Cumulative Effects on Human Health.

Cumulative effects on human health would derive from impacts to subsistence, degradation of air quality, pollutant emissions, and the sociocultural effects discussed above. Effects which should be considered would include:

- Increasing rates of diabetes and metabolic problems, and the resultant increases in cardiovascular and cerebrovascular disease, chronic renal disease and renal failure, and peripheral vascular disease. The degree to which these problems occur would depend on a complex interplay between sociocultural impacts which may over time displace the importance of subsistence foods in the diet (if not the culture as a whole), and the degree to which subsistence harvests are impacted by industrial activities and global warming.

Public health professionals in Alaska worry that, given the prevalence of other risk factors for metabolic problems—including a likely genetic predisposition, high smoking rates, and relatively high rates of obesity—displacing subsistence from its primary place in the diet could trigger a severe epidemic of these problems, such as has been observed in many Tribes in the lower 48 states.

- Increasing social pathology. To a great degree, this would depend on the balance between positive aspects of development—including economic opportunity, improvements in infrastructure, employment and educational opportunity—and the adverse aspects, such as increasing economic disparity within communities, economic depression under the “boom and bust” cycle often associated with resource development in regions with little other established economic potential, and sociocultural impacts leading to acculturation stresses and importation of drugs and alcohol into the community. Overall, the most important point to make regarding social pathology is that, given the already strained baseline described in Section III.B.15.d, these communities are highly vulnerable, and efforts should be maximized to avoid worsening the situation.

- Increasing injury rates. If social pathology increases, we may see an increase in accidents and intentional injuries, reflecting more prevalent alcohol and substance abuse, as well as increasing risk-taking behavior. Subsistence impacts could worsen this problem.
- Increasing respiratory problems related to incremental degradation of air quality near villages and around subsistence areas. This can best be addressed through a commitment to strict adherence to the best available emissions control technologies, and improved monitoring programs.
- Increasing rates of contaminant-related cancers, endocrine problems, and neurodevelopmental deficits. Unfortunately, given the rarity of each individual cancer, the long latency between exposure and development of a cancer, and the small numbers of people in each village, it will be extremely difficult to unravel the complex pathogenesis of these problems to fully elucidate the contribution of oil and gas activities to overall rates. Consequently, the only valid public health strategies available rely on preventing exposure. This can best be accomplished through a combination of improved monitoring of health outcomes and pollutant levels in subsistence areas, and requirements to minimize emissions through utilization of the best available control technology.

Ultimately, the most effective strategies to protect human health will depend on developing a monitoring strategy which identifies and tracks important regional health indicators and continuing to develop a more detailed understanding of the ways in which the determinants of health are impacted by development. In turn, this information may inform efforts to both refine existing mitigation measures and develop new measures which target health outcomes and health determinants specifically. The MMS is committed to pursuing this effort in cooperation with the Tribes, the NSB, and the Alaska Inter-Tribal Council.

V.C.16.d. Cumulative Climate Change Impacts.

Because potential climate change impacts on marine and terrestrial ecosystems in the Arctic would cause significant impacts on subsistence resources, traditional culture, and community infrastructure, subsistence-based indigenous communities in the Arctic and in Alaska's Chukchi and Beaufort sea regions would be expected to experience disproportionate, high adverse environmental and health effects (see the discussion on global climate change in the subsistence-harvest patterns cumulative effects section).

Conclusion. Potential significant impacts to subsistence resources and harvests and consequent significant impacts to sociocultural systems would indicate significant cumulative environmental justice impacts—disproportionate, high, adverse environmental and health effects on low-income, minority populations in the region. Alaskan Inupiat Natives, a recognized minority, are the predominant residents of Chukchi Sea coastal communities in the NWAB, the area potentially most affected by past, present, and reasonably foreseeable projects on- and offshore in the Chukchi and Beaufort sea regions.

Environmental Justice 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 would focus on the Inupiat communities of Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and subsistence communities on the Russian Arctic Chukchi Sea coast. Major effects are not expected from routine activities and operations; however, if 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.

Additionally, cumulative onshore development, especially from potential road development within NPR-A and Alpine satellite field expansion, could impact subsistence resources and harvest practices. Subsistence resources, particularly caribou, could experience long-term disturbance and displacement effects, as well as functional loss of habitat and potential population reductions, causing subsistence hunters to alter traditional harvest practices by having to travel to unfamiliar areas. If this occurred, long-term displacement of ongoing social systems would be expected. Community activities and traditional practices for harvesting, sharing, and processing subsistence resources would be altered, and disproportionate, high, adverse effects would be expected for the Inupiat communities of Barrow, Wainwright, Point Lay, and possibly Point Hope.

Potential impacts on human health from contaminants in subsistence foods and long-term climate change impacts on marine and terrestrial ecosystems in the Arctic—affecting subsistence resources, traditional culture, and community infrastructure of subsistence-based indigenous communities in the NSB and NWAB—would be an expected and additive contribution to cumulative environmental justice impacts. Potential disproportionately

high adverse effects on low-income, minority populations in the region effects are expected to be mitigated substantially but not eliminated.

Contribution of Alternative I to Cumulative Impacts. The Proposed Action would represent a small percentage of the foreseeable cumulative activities. Only in the event of a large oil spill would disproportionate high adverse effects be expected on Alaskan Natives.

SECTION VI

CONSULTATION AND COORDINATION

Contents for Section VI

VI.A. Development of the Proposal VI-
VI.B. Development of the EIS VI-1
VI.C. Review of the Draft EIS VI-2
VI.D. Consultation VI-7

VI. CONSULTATION AND COORDINATION

VI.A. Development of the Proposal.

In 2002, the Secretary of the Interior issued the Final OCS Oil and Gas Leasing Program for 2002-2007 (5-Year Program). That document presented her decision to consider annual “special-interest” sales in the Chukchi Sea/Hope Basin OCS Planning Areas. The objective of this “special-interest” leasing option was to foster exploration in a frontier OCS area with potential oil and gas resources but may have minimal industry interest because of high operating costs. The general approach for special interest leasing was to query industry regarding the level of interest for proceeding with a sale in an area such as the Chukchi Sea/Hope Basin. We expected nominations of focused areas of specific industry interest or to offer such areas for lease. Based on the information and specific nominations received as a result of each Call for Interest and Nominations (Call), a decision was made whether to proceed with the sale process.

We received no indication of interest in response to the first two Calls for special interest leasing in the Chukchi Sea/Hope Basin published in the *Federal Register (FR)* on March 25, 2003 (68 *FR* 14425), and January 30, 2004 (69 *FR* 4532); therefore, the process was stopped.

In response to the third Call published in the *Federal Register* on February 9, 2005 (70 *FR* 6903), industry nominated a substantial portion of the Planning Area. This area was greater than that envisioned in the special interest lease-sale option described above. The MMS concluded that consideration of such a large area had merit in light of the significant resource potential of the area and the Administration’s goal to expedite exploration of domestic energy resources. The MMS further concluded that consideration of such a proposed action warranted a more extensive National Environmental Policy Act (NEPA) review than contemplated under the special interest leasing option.

With the publication of a Notice of Intent to Prepare an Environmental Impact Statement in the *Federal Register* on September 14, 2005 (70 *FR* 54406), MMS initiated the process to prepare a comprehensive “areawide” EIS for the so-designated Lease Sale 193. However, the prelease process and EIS will not be completed in time to allow the Sale during the 2002-2007 5-Year Program, which expires on June 30, 2007. Lease Sale 193 is tentatively scheduled for February 2008, subject to its retention in the 2007-2012 5-Year Program for 2007-2012 and final adoption of the Program by the Secretary of the Interior.

VI.B. Development of the EIS.

During preparation of this Chukchi Sea Planning Area Lease 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 Chukchi Sea Planning Area lease sales were relevant to this proposed lease sale. 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, Wainwright, Point Hope, Point Lay, 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 the Scoping Report on the MMS website. The North Slope Borough local communities, in addition to Federal agencies with interest and expertise in the OCS, were consulted during the development of the potential mitigating measures for the proposed action.

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, Wainwright, Point Lay, and Point Hope; 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 phone and given the opportunity to host government-to-government consultation meetings for scoping and the development of this EIS.

VI.C. Review of the Draft EIS.

The following is a list of the Federal, State, Tribal and local government agencies; academic institutions; members of the oil and gas industry; special interest groups; other organizations; and private citizens who were sent copies of the draft EIS for review.

Federal – Executive Branch

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

Tribal and 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	National Oceanic and Atmospheric Administration Information Services Division, Seattle, WA
Alaska Resources Library and Information Service (ARLIS)	North Slope Borough School District Library/Media Center, Barrow
Alaska State Library Government Publications, Juneau	Northern Alaska Environmental Center Library
American Petroleum Institute Library, D.C.	Tikigaq Library, Point Hope
Canadian Circumpolar Library, Edmonton AB	Trapper School Community Library, Nuiqsut
Canadian Joint Secretariat Librarian, Inuvikon NT	Tuzzy Consortium Library, Barrow
Department of Indian and Northern Affairs, Canada Yellowknife, NT	University of Alaska, Anchorage Elmer E. Rasmuson Library Government Documents
Environmental Protection Agency, Region 10 Librarian, Seattle	University of Alaska, Fairbanks Geophysical Institute Government Documents
Fairbanks North Star Borough Noel Wien Library	Institute of Arctic Biology
George Francis Memorial Library	University of Alaska, Southeast (Juneau)
Ilisaavik Library, Shishmaref	U.S. Army Corps of Engineers Library, Anchorage
Juneau Public Library	Valdez Consortium Library
Kaveolook School Library, Kaktovik	Z.J. Loussac Library, Anchorage
Kegoyah Kozpa Public Library, Nome	

Canada

Department of Fisheries and Oceans Institute of Ocean Sciences, Sidney, BC	Department of Indian and Northern Affairs Natural Resources and Economic Development, Ottawa
Canadian Wildlife Service National Wildlife Research Division, Hull, PQ	

Special Interest Groups

Alaska Conservation Foundation	Indigenous Peoples Council for Marine Mammals
Alaska Native Knowledge Network, Fairbanks	KBRW News, Barrow
Alaska Natural Heritage Program	Living Resources, Inc. Fairbanks
Alaska Public Interest Research Group	Marine Advisory Program
Arctic Connections	National Audubon Society
Arctic Marine Resource Commission	National Parks and Conservation Association
Arctic Sounder, Kotzebue	Natural Resources Defense Council
Barrow Cable TV	National Wildlife Federation
Bering Air, Inc., Nome	Northwest and Alaska Fisheries Center
Center for Biological Diversity	Ocean Conservancy
Defenders of Wildlife	Rural CAP Subsistence/Natural Resources Dept.
EarthJustice, Juneau	Sierra Club
Exxon Valdez Oil Spill Trustee Council	Trustees for Alaska
Greenpeace	University of Alaska, AEIDC, ENRI
Ilisagvik College, Barrow	Wilderness Society
	Wildlife Federation of Alaska

Petroleum Industry

AEC Oil and Gas (USA) Inc.	Exxon Mobil Oil Corporation
Alaska Clean Seas	Exxon Mobile Production Company
Alaska Support Industry Alliance	Forest Oil Corporation
Amerada Hess Corporation	Marathon Oil Company
American Petroleum Institute	Murphy Exploration (Alaska), Inc.
Amoco Production Co.	Pennzoil
Anadarko Petroleum Corporation	Petro-Canada (Alaska) Inc.
Armstrong Oil and Gas Inc.	Phillips Alaska, Inc.
Atofina Petrochemicals, Inc.	Environmental Protection Dept.
BP Exploration (Alaska) Inc.	Phillips Petroleum Company
Records Mgmt.	Shell Frontier Oil & Gas, Inc.
Lands Mgr.	Texaco Inc.
Chevron U.S.A. Inc.	Union Oil Company of California
Conoco, Inc.	Western Geophysical Company
Encana Oil and Gas, Inc.	

Associations, Companies, and Other Groups

Alaska Journal of Commerce	I.H.S. Energy
Alaska Marine Conservation Council	LGL, Environmental Research
Alaska Newspapers, Inc.	Lynx, Inc.
Alaska Oil and Gas Association	Oil and Gas Journal
Alaska Public Radio Network, Anchorage	Prince William Sound RCAC
Anchorage Daily News	Regional Director, MMS, GOM OCS Region
Continental Shelf Associates	Regional Director, MMS, Pacific OCS Region
Fairbanks Daily News-Miner	Steven R. Braund and Associates
Guess and Rudd P.C.	URS Corporation
	Waddell Marine Biotech

Individuals

Patsy Aamodt, Barrow	Herbert Ipalook, Nuiqsut	Enoch Oktollik, Wainwright
Fred Ahmaogak, Wainwright	Edward Itta, Barrow	James Paktotak, Barrow
George N. Ahmaogak, Barrow	Kathy Itta, Barrow	Emily Paniger, Nuiqsut
Maggie Ahmaogak, Barrow	Shirley Kagak, Atqasuk	Peter Panik, Wainwright
Morjorie Ahnupkana, Nuiqsut	Fred Kanayurak, Barrow	Delbert Rexford, Barrow
Rosemary Ahtuanguaruak, Nuiqsut	Lydin Kisoalik, Nuiqsut	Fenton Rexford, Kaktovik
Freddie Aishanna, Kaktovik	Jake Koonuk, Point Hope	Ladorne Rexford, Nuiqsut
Bendell Akootchook, Kaktovik	Maggie Koraldy, Nuiqsut	Rosabelle Rexford, Barrow
Isaac Akootchook, Kaktovik	Sarah Kunaknony, Nuiqsut	Jack Schaefer, Point Hope
Joseph K. Akpik, Barrow	Bernie Kyld, Nuiqsut	Willie Sielak, Jr., Nuiqsut
Jim T. Allen, Nuiqsut	Doreen Lampe, Barrow	Aunuptana Simiktug, Nuiqsut
Lou I. Angisan, Kaktovik	Leonard Lampe, Nuiqsut	Abe Simmonds, Nuiqsut
Walt Audi, Kaktovik	Martha Larepe, Nuiqsut	Nolan Soloman, Kaktovik
Earl H. Beistline, Fairbanks	William Leavitt, Barrow	Lon Sonsalla, Kaktovik
Barry Bodfish, Wainwright	Jessica S. Levre, Alexandria, VA	Jim Stimpfle, Nome
Arnold Brower, Jr., Barrow	Marie Lisborne, Point Lay	Debbie Suvlu, Barrow
Charlotte Brower, Barrow	Tom Lohman, Anchorage	Edward Syrjala, Centerville, MA
Eugene Brower, Barrow	Dr. Don Ljungblad, Elk Mountain, WY	George Tagarook, Kaktovik
Gordon Brower, Barrow	Frank Long, Nuiqsut	Harry Tazruk, Wainwright

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
Maggie Hopson, Nuiqsut
Harry Hugo, Anaktuvuk Pass

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

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
Jobe Woodson, Nuiqsut
Sheri Yatlin, Fairbanks

VI.D. Consultation.

On August 12, 2005, MMS requested from NMFS a list of threatened, endangered, and candidate species and critical habitats under their jurisdiction pursuant to section 7 of the Endangered Species Act. The NMFS responded with a list that included the endangered bowhead whale and noted critical habitat has not been designated for bowhead whale (dated September 30, 2005). The NMFS also noted that the endangered humpback and fin whale are found in the Chukchi and Bering seas outside of the OCS Planning Areas. The MMS provided a request for Arctic Regionwide consultation and a biological evaluation (BE) (dated March 3, 2006). The MMS described the anticipated impacts that OCS activities, including exploration seismic surveys, could have on endangered bowhead whales. The MMS also included a discussion of potential impacts to the endangered humpback and fin whale. The BE discussed mitigation measures to avoid and minimize impacts to these species. On June 16, 2006, NMFS provided their Arctic Region Biological Opinion (ARBO) stating that the activities associated with seismic surveys in the Beaufort and Chukchi seas may adversely affect but not jeopardize the continued existence of any species listed under the ESA that is under the jurisdiction of NMFS. Correspondence related to this consultation is provided in Appendix B. The BE MMS submitted to NMFS is on the MMS website at http://www.mms.gov/alaska/ref/Biological_opinionsevaluations.htm and the NMFS ARBO is also available at the same website or from the NMFS EIS Coordinator.

The NMFS agreed to become a cooperating agency (as that term is defined in 40 CFR 1501.6) on this EIS to provide NEPA documentation for the possible issuance of Letter of Authorization (LOAs) and Incidental Harassment Authorizations (IHA) to the offshore oil and gas industry, principally the seismic-survey industry, to take marine mammals by harassment, incidental to conducting prelease and ancillary on-lease oil and gas seismic surveys in the Chukchi Sea (see Sec. I.A.1 Regulatory Framework). NMFS proposes to adopt this EIS as authorized by 40 CFR 1506.3 as its own NEPA statement.

On December 13, 2005, MMS requested from FWS a list of threatened, endangered, and candidate species and critical habitats under their jurisdiction pursuant to section 7 of the Endangered Species Act. The FWS responded with a list that included the spectacled eider (threatened), the Steller's eider (threatened), and the Kittlitz's murrelet (a candidate species), and the Ledyard Bay critical habitat area. On May 25, 2006, MMS requested verification that this species list was current; FWS concurred on June 2, 2006.

The MMS prepared a BE and determined that Lease Sale 193 was likely to adversely affect listed species and modify critical habitat. The MMS requested formal Section 7 consultation with the FWS and submitted the BE to them on September 21, 2006. On October 27, 2006, the FWS acknowledged receipt of the BE, stating it was complete and that they would provide their BO to MMS on or before February 7, 2007. The MMS received the FWS BO on March 28, 2007. Correspondence related to formal consultation is in Appendix C. The BE MMS submitted to FWS is available on the MMS website at http://www.mms.gov/alaska/ref/Biological_opinionsevaluations.htm or MMS, and the FWS BO is available at the above website or from the FWS Field Office in Fairbanks, Alaska.

VI.E. Contributing Authors and Supporting Staff Members.

Elinore M. Anker, Technical Publications Writer-Editor
 Christy Bohl, Oil Spill Response Plan Coordinator
 Michael Burwell, Socioeconomic Specialist
 Estrella Campellone, (Corps of Engineers) Plant Ecologist
 Doug Choromanski, Geologist
 Jim Craig, Ph.D., Geologist
 Deborah Cranswick, Chief, Env Assessment Section
 Wayne Crayton, Wildlife Biologist
 Daniel Hartung, Resource Analyst
 Mike Hay, GIS Contractor
 Tim Holder, Socioeconomic Specialist

Lewandowski, Jill, Protected Species Biologist
 Harry Luton, Sociologist
 Ida Menge, Cartographer
 Thomas Newbury, Biological Oceanographer
 Michael Salyer, Wildlife Biologist, EIS Coordinator
 Steve Flippen, Minerals Leasing Specialist
 Lisa Rotterman, Ph.D., Wildlife Biologist
 Mark Schroeder, Wildlife Biologist
 Kirk Sherwood, Ph.D., Geologist
 Caryn Smith, Oceanographer
 Dennis Thurston, Geophysicist

Chris Hoffman, (Corps of Engineers) Wildlife Biologist
Dave Johnston, Minerals Leasing Specialist
Jim Lima, Ph.D., Socioeconomic Specialist

Jim Wilder, Wildlife Biologist

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.



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MMS 2007-026

Chukchi Sea Planning Area
Oil and Gas Lease Sale 193 and Seismic Surveying Activities
Final Environmental Impact Statement VOLUME I

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